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Accounting for Cryptocurrencies and Block Chain Technology

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Abstract: *There are many important milestones in mankind's history. The invention of writing, the industrial revolution, the development of firearms, and geographical explorations are examples of these milestones. The discovery of money also has great importance because it provides a standard measurement of value and it is very difficult to make trade between parties without it. The invention of the Internet also has had a considerable impact on the development of international trade as well as the increase in usage of money in daily life. Furthermore, there have been notable developments in the field of technology in the last century. The widespread use of the Internet has brought digitalization to almost every field. Especially e-commerce has reached huge volumes and very large-scaled global shopping sites have appeared like Amazon, Alibaba, eBay, and Walmart. The digitalization that started with the Internet has increased the economic interaction between countries and the world is globally integrated by eliminating the borders in the economic sense.*

Due to the digitalization and globalization in the world, new developments, new rules, and new problems have arisen in the areas of accounting, finance, payment systems, fund transfers, storage, and the transfer of data. Blockchain Technology (BCT) and cryptocurrency1 are two of the most important developments over the last decade.

Keywords: Blockchain Technology

I. INTRODUCTION

There are many important milestones in mankind's history. The invention of writing, the industrial revolution, the development of firearms, and geographical explorations are examples of these milestones. The discovery of money also has great importance because it provides a standard measurement of value and it is very difficult to make trade between parties without it. The invention of the Internet also has had a considerable impact on the development of international trade as well as the increase in usage of money in daily life. Furthermore, there have been notable developments in the field of technology in the last century. The widespread use of the Internet has brought digitalization to almost every field. Especially e-commerce has reached huge volumes and very large-scaled global shopping sites have appeared like Amazon, Alibaba, eBay, and Walmart. The digitalization that started with the Internet has increased the economic interaction between countries and the world is globally integrated by eliminating the borders in the economic sense.

Due to the digitalization and globalization in the world, new developments, new rules, and new problems have arisen in the areas of accounting, finance, payment systems, fund transfers, storage, and the transfer of data. Blockchain Technology (BCT) and cryptocurrency1 are two of the most important developments over the last decade. After Nakamoto's (2008) "Bitcoin: A peer-to-peer electronic cash system" article, BCT and cryptocurrencies gained prevalence. Nakamoto (2008) states that the existence of the trusted party in the electronic payment systems is increasing the cost of money transfers from one to another. Therefore, there is a need for a payment system that enables individuals to transfer money between two parties without a third party. To meet this need, an electronic system was developed, which is "peer-to-peer" and based on cryptology, which allows transacting directly with each other. Blockchain has been embedded in a lot of areas, particularly, the digital platforms based on BCT have been developed and submitted to the banking sector and financial industries. "Stel- la" is a joint project of the European Central Bank and the Bank of Japan. They have been working on assessing the applicability of Distributed Ledger Technology (DLT) solutions in financial market infrastructures since 2016 and they report the aim of "Stella" as "to contri- bute to the

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ongoing broader debate around the potential usability of DLT while not being ge- ared towards replacing existing central bank services with DLT-based solutions" (European Central Bank and Bank of Japan, 2018).

Accounting professionals and academics cannot stand unresponsive to the development of the BCT and have been searching for possible usage areas of this technology in accounting. Big accounting firms have started to develop software applications based on BCT and to pro- mote the usage of blockchain. New debates have arisen on the accounting of cryptocurrencies and the requirement for new IFRSs, which will conform to BCT.

This study aims to make a systematic literature review to understand the potential effects of BCT on accounting and make some inferences for the future of the accounting profession. In order to increase the understandability of the research topic, blockchain and cryptocurrency concepts are explained in the following part. The research methodology of this study is explained in the third part. The fourth part summarizes the related literature, and the fifth part is the conclusion.

Cryptocurrency and Blockchain Technology

Human beings used to barter under primitive conditions. When life became more comp- lex and bartering was not sufficient, it became necessary to fix a particular commodity as a "medium of exchange and a measure of value". This intermediate commodity which is called "money" has appeared in many different forms such as cattle, iron, salt, shells, dried cod, tobacco, sugar, nails, stone, etc. in different times and places (Innes, 1913; Keynes, 1915). Historical records show that leather money was in usage in China approximately 100 B.C. and again the first money which was made from paper also emerged in China in 806 (Central Bank of the Republic of Turkey, 2018) In short, everything can be used as "money" if it has the following three attributions: "mediating to an exchange", "being used as the unit of acco- unt" and "a storage of value" (Asmundson and Oner, 2012; Yermack, 2013).

Cryptocurrency is defined as "a digital representation of value that can be digitally tra- ded and functions as (1) a medium of exchange; and/or (2) a unit of account; and/or (3) a store of value, but does not have legal tender status in any jurisdiction" by Financial Action Task Force in 2014. In other words, cryptocurrencies are neither issued by a central bank nor controlled by a public authority as shown in Table 1, but they represent a value and have been used as an instrument of payment since the beginning of 2009 and have been traded digitally (European Banking Authority, 2014).

Table 1
A Money Matrix

		Form of the Money	
		Physical	**Digital**
Legality	Regulated	Banknotes and Coins	E-Money Commercial Bank Money (Deposits)
	Unregulated	Certain Types of Local Currencies	Cryptocurrencies

Source: European Central Bank, 2012

Cryptocurrencies are generally under the control of their developers and used as "real" money within the members of a specific group. There are three types of schemes as follows: "closed schemes", "unidirectional schemes" and "bidirectional schemes". The closed sche- mes are generally used in online games. There is only one type (in/out), which flows in a unidirectional scheme. The third type of scheme allows cryptocurrencies to act just like fiat money by setting a buy and sell rate (European Central Bank, 2012). The first cryptocurrency appeared in 2009 in the name of Bitcoin. "Bitcoins are digital coins which are not issued by any government, bank, or organization, and rely on cryptographic protocols and a distributed network of users to mint, store, and transfer" (Ron and Shamir, 2013: 6). Since then, lots of cryptocurrencies have been launched in the financial markets. There are 5,903 cryptocurren- cies2 in the world as of June 2021, and Bitcoin has the largest market share. Countries have different approaches on cryptocurrencies. Generally, cryptocurrencies are evaluated from tax and illegal acts perspectives. While some countries have forbidden the usage of cryptocurren- cies, some others accepted them as a legal payment tool (Yıldırım, 2019).3

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It is not possible to think of trading activities without recording the transactions, so ledger accounts have been used for record-keeping since ancient times. However, their shapes have evolved from tablets to papyrus, parchment to papers, and bytes over time. A new era has started in the ledger accounts with cryptocurrencies and the algorithmic software DLT has been developed in the last decade (Walport, 2015). Because DLT has been implemented in a variety of industries, it does not have a common single definition. The meaning of DLT differs according to the usage area (Mills et al., 2017). Even if the definitions of DLT are different from each other, the "peer-to-peer network system" and "decentralized" or "distributed" terms are fixed parts of all definitions. Another term that has the same meaning as DLT is "blockchain". "Blockchain is the ledger (book of records) of all transactions, grouped in blocks, made with a (decentralized) virtual currency scheme" (European Central Bank, 2015). Blockchain or DLT is a kind of database which is based on a "peer-to-peer" network philosophy and it makes the records non-deletable forever (Swanson, 2015) and it is possible to keep records by many people or organizations and no one is superior or inferior to others (Kornfeld et al., 2016).

Blockchain is the combination of blocks that can include a large number of transaction data and follow each other. Each block has a hash value. The first block is called a Genesis block and because there is no block before it, its hash value is zero. Each block contains the previous block's hash code to keep the connectivity of the blocks (Bamakan et al., 2020).

Members who want to participate in a particular blockchain use nodes (computer devi- ces), which are connected. When one member creates a block, other nodes have the right to accept or reject it.

Members should also make an agreement related to the rights of partici- pants in the blockchain. These agreements are called "consensus algorithms". The blockchain consensus algorithms developed till now are Proof of Work, Proof of Stake, Delegated Proof of Stake, Proof of Elapsed Time, Practical Byzantine Fault Tolerance, Delegated Byzantine Fault Tolerance, Proof of Weight, Proof of Burn, Proof of Capacity, Proof of Importance, Proof of Activity, and Directed Acyclic Graphs. They differ according to their decentraliza- tion and security levels, energy consumptions, degree of difficulty, and participation level of nodes (Bamakan et al., 2020; Yu et al., 2020).

According to accessibility and controllability by the network members, there are three categories of blockchain: (1) a public blockchain can be accessed, shared, and controlled by all the members, (2) in a private blockchain, the access can be with the permission of a third party and it is centralized to some extent, and (3) a consortium blockchain is governed by several institutions all of which directly participate in the consensus protocol (Ali et al., 2020; Salimitari et al., 2020).

The intermediary functions or the third parties have disappeared with the blockchain. Blockchain uses a decentralized ledger, so that, it enables each user to copy all records onto their computers. However, it is not possible in the existing system which allows only trusted parties to hold all transaction records, especially in bank accounts. Because the BCT makes the transactions immutable and reduces anonymity, government services may also adopt BCT to increase transparency and accountability (Boucher et al., 2017).

One of the concepts that cannot be separated from the blockchain, especially when we look through an accounting perspective, is the Internet of Things (IoT). "The Internet of Things (IoT) is set to ubiquitously connect a huge number of devices (embedded with sen- sors and actuators) to the Internet, digitizing the physical world into computer-based data systems" (Wang et al., 2019: 1). "Built-in blockchain" and "Blockchain as a service" are the two types of blockchain for IoT. In the first one, IoT devices are built-in, which means all IoT devices can operate as blockchain nodes and become part of a blockchain network. In the second one, the data collected by an IoT device is entered into the blockchain by a user (Wang et al., 2019).

Although most of the studies focus on the blockchain usage as a means of cryptocurrency transfer, this technology can also be used for non-financial activities, such as supply cha- in management, voting in elections, healthcare records management, identity management systems, access control systems, decentralized notary and tourism organizations (Boucher et al., 2017; Maesa and Mori, 2020; Rashideh, 2020).

Some researchers suggest different types of blockchains. For example, Back et al. (2014) propose "pegged sidechains", which allow the transfer of coins between multiple blockchains and makes interoperation with each other easier. Wang and Kogan (2018) take a step further and propose a framework design for a blockchain-based transaction processing system for the implementation of blockchain for accounting and auditing fields. They assume a blockcha- in-based enterprise and represent its assets and resources with different tokens and different side chains. Every digital coin in the

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blockchain is a token. Vincent et al. (2020) design a blockchain that enables auditors to participate in the client's blockchains and use them in audit processes. Lafourcade and Lombard-Platet (2020) go even further and test the interope- rability of two blockchains.

There are also some studies mentioning the drawbacks of blockchain, such as execution and storage costs, energy consumption, global warming, and cybercrime problems. Block- chain systems are expensive and consume a huge level of electricity. Additionally, because countries have not made laws related to bitcoin and blockchain, when there is fraud, cyberc- rime, terrorist financing, or any conflict between the parties, it is not clear how to solve these problems (Chang et al., 2020).

Blockchain in Cryptocurrency

Bitcoin, Ethereum, and other wide-scale cryptocurrency coins use blockchain to process and record transactions securely. This remains the primary use of the technology. However, it is making its way into projects outside of cryptocurrency. Understanding how these blocks are coded and how different industries may benefit from this application can help you market yourself to new roles in this field.

Use of Blockchain in Cryptocurrency

The use of blockchain for currency is currently the most common use of this technology. Bitcoin, Ethereum, and other wide-scale cryptocurrency coins use blockchain to process and record transactions securely. This technology makes it possible to ensure transparency and protect the financial information and identity of crypto buyers and sellers.

Blockchain Applications Beyond Cryptocurrency

The success of blockchains for currencies has opened the door to many opportunities for expansion. The technology can increase connectivity and transparency between organizations and streamline processes.

Examples:

For example, using smart contracts can simplify transactions and business payments. These smart contracts set up a list of conditions to be met and code the payment to be released once users meet the conditions. Blockchain technology can provide templates for these contracts and simplify payments since they don't need intermediaries.

1. Payment processing and financial transactions:

The use of blockchain in the financial industry has the opportunity to make transactions more efficient. It may streamline international and domestic transactions, reduce transaction fees, and increase transparency. Visa has shown the efficacy and potential of blockchain technology for mainstream use since adopting blockchain for international business payments in 2017 [1].

2. Recording property records and real estate transactions:

Blockchain technology can record the transaction records for property in a transparent, widely available, and secure way. This allows the public access to an indisputable record of property ownership and makes these records more easily available than following a paper trail. When it's time to sell, verifying and transferring ownership can be done more efficiently.

3. Securing patient information:

Inefficient hospital record-keeping and lack of security have caused problems for providers and patients. Blockchain technology has the potential to secure patient data, track outbreaks of diseases, and create more accessible hubs of medical information. Instead of tracking data across all locations, patients and providers can access all the information in a decentralized database.

4. Streamlining the supply chain:

Blockchain technology offers two key benefits to supply chain functions: improved data security and communication. Manufacturers, shippers, and customers have access to the most up-to-date information about the shipping process. Not only does this keep everyone in the loop, it can also improve coordination between supply chain partners and reduce execution errors.

5. Tracking voting records:

The immutable nature of blockchain makes it appealing to election officials who want to increase public confidence in election results. Blockchain technology could promote transparency in election results and securely store records of all

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votes. Not only does it create a permanent register of votes, but it can reduce the possibility of voter fraud since each ballot corresponds to a single ID.

TYPES

Cryptocurrencies:

Bitcoin: Launched in 2009, Bitcoin is the first and most well-known cryptocurrency. It operateson a decentralized peer-to-peer network, allowing users to conduct transactions without the need for a central authority.

Ethereum: Beyond being a cryptocurrency, Ethereum introduced smart contracts, enabling self-executing agreements with predefined rules.

Ripple: Designed for fast and low-cost international transactions, Ripple focuses on providingsolutions for banks and financial institutions.

Blockchain Technologies:

Public Blockchain: Open to anyone, providing transparency and security. Bitcoin operates ona public blockchain.

Private Blockchain: Restricted to a specific group or organization, offering more control overaccess and permissions.

Consortium Blockchain: Shared among a group of organizations, combining the benefits ofboth public and private blockchains.

ADVANTAGES AND DISADVANTAGES OF BLOCKCHAINS

Many industries are seeing the advantages of blockchain for storing, recording, and securing their data, such as global access and increased privacy. While specific advantages and disadvantages of blockchain uses will differ by industry, common advantages include the following:

Advantages:

Anonymity: Blockchain technology allows you to create transactions under pseudonyms without being attached to your identity. While the record is available publicly, the identities ofthe people making them often are not.

Cost: Blockchain technology can potentially reduce the cost of international transactions. This comes from lower transaction fees, reduced need for an intermediary, and automated smart contracts to streamline transactions.

Decentralization: The decentralized nature of blockchain means records remain consistent records across locations and countries. This diminishes discrepancies in data and ensures professionals have access to the same information.

Increased privacy: Blockchain encrypts data and uses a system that prevents data corruption.Private key authentication is used to protect data, so network administrators only have access to an overview of the data and not user-specific information.

Permanent records: Each data block has a cryptographic signature that validates that the information has not been tampered with. Because blockchain information exists across many devices, the data record stays forever. This takes away debate about the validity of the records.

Security: Blockchains are not kept in a centralized location, so hackers cannot disrupt or corrupt the data. The blockchain is continually updated to nodes worldwide and provides an indisputable record of data and transactions.

Streamlined processes: Blockchain technology can provide templates for smart contracts, making it easier for businesses to set up transparent, efficient, and secure business deals. Smartcontracts with blockchain reduce the steps to complete a transaction and process payments quicker.

Disadvantages:

Technological Barriers: Implementing blockchain technology requires technical expertise and may be challenging for businesses without the necessary resources. The learning curve andinitial setup costs can be barriers to adoption.

Privacy Concerns: While blockchain provides a degree of transparency, the pseudonymous nature of transactions raises privacy concerns. Striking a balance between transparency and user privacy can be challenging.

Regulatory Uncertainty: The lack of clear and consistent regulatory frameworks globally introduces uncertainties for businesses. Compliance requirements may differ, and evolving regulations can impact accounting practices

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ADVANTAGES AND DISADVANTAGES OFCRYPTOCURRENCIES

Advantages:

Efficiency and Speed: Cryptocurrency transactions occur in real-time and directly between parties, eliminating the need for intermediaries. This leads to faster processing times and increased operational efficiency.

Cost Savings: Lower transaction fees, especially for cross-border transactions, can result in significant cost savings compared to traditional financial systems.

Global Accessibility: Cryptocurrencies operate on a global scale without reliance on traditional banking hours or geographical constraints. This facilitates 24/7 accessibility for businesses and individuals.

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Global Accessibility: Cryptocurrencies operate on a global scale without reliance on traditional banking hours or geographical constraints. This facilitates 24/7 accessibility for businesses and individuals.

Disadvantages:

Volatility: The value of cryptocurrencies can be highly volatile, posing risks for financial reporting and valuation. Businesses that hold cryptocurrencies may face challenges in accounting for their fluctuating values.

Regulatory Uncertainty: The lack of clear and consistent regulatory frameworks globally introducesuncertainties for businesses. Compliance requirements may differ, and evolving regulations can impactaccounting practices.

Complex Accounting Standards: Accounting for cryptocurrencies can be complex due to the absenceof clear accounting standards. Determining fair value, impairment, and recognition can be challengingand may vary across jurisdictions

Security Concerns: While blockchain is inherently secure, the surrounding infrastructure, such as cryptocurrency exchanges, may be vulnerable to hacking and security breaches. This can lead to the loss of assets and pose risks for businesses.

Limited Acceptance and Integration: Limited acceptance by businesses and regulatory bodies may hinder seamless integration into accounting processes. The lack of infrastructure and support may limit the practical use of cryptocurrencies

FEATURES

Cryptocurrencies:

Decentralization: Cryptocurrencies operate on a decentralized network of computers, commonly known as a blockchain. This means there is no central authority, such as a government or financial institution, governing or controlling the currency. Instead, transactions are verified and recorded through a consensus mechanism involving network participants (nodes).

Significance: Decentralization reduces the risk of manipulation or control by a single entity, promoting a more democratic and transparent financial system.

Security: Cryptocurrencies use advanced cryptographic techniques to secure transactions. Public and private keys are utilized to encrypt and decrypt transaction information, ensuring the confidentiality and integrity of the data. Additionally, the decentralized nature of blockchainadds an extra layer of security.

Significance: Cryptography enhances the security of transactions, making it extremely difficultfor unauthorized parties to tamper with or forge transaction data, thereby reducing the risk of fraud.

Anonymity: Cryptocurrencies provide a degree of user anonymity. While transactions are recorded on the public blockchain, users are identified by cryptographic addresses rather thanpersonal information. This pseudonymous nature allows users to conduct transactions withoutrevealing their identities.

Significance: Anonymity enhances privacy for users, making it more challenging to trace andassociate transactions with specific individuals. However, it also raises considerations regarding the potential misuse of this feature for illicit activities.

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Blockchain Technology:

Transparency: Blockchain is a distributed ledger that records all transactions across a network of participants. Every participant has access to an identical copy of the ledger, creating transparency. Transactions are visible and verifiable by all participants, promoting trust withinthe network.

Significance: Transparency ensures that all involved parties can independently verify the validity of transactions, reducing the risk of fraud and enhancing trust in the system.

Immutability: Once a block of transactions is added to the blockchain, it becomes practically impossible to alter or delete. Each block contains a cryptographic hash of the previous block, creating a chain of blocks that are linked and secured through complex mathematical algorithms.

Significance: Immutability ensures the permanence of transaction records. Once recorded, a transaction is secure from tampering, providing a reliable and unchangeable history of all transactions on the blockchain.

Smart Contracts: Smart contracts are self-executing contracts with coded terms written into the blockchain. These contracts automatically execute and enforce predefined rules when specific conditions are met, without the need for intermediaries.

Significance: Smart contracts streamline and automate contractual processes, reducing the need for manual intervention and the potential for disputes. They enhance efficiency, transparency, and trust in agreements executed on the blockchain

THE RESEARCH METHODOLOGY OF THE STUDY

Bitcoin and blockchain, which occupy an important place in the world's agenda, are mentioned in the article of Nakamoto for the first time in 2008. There are hundreds of studies that have been carried outon Blockchain, Distributed Ledger Technology (DLT), and cryptocurrencies since 2008 in literature. Therefore, this study systematically reviews the academic studies published between 2008 and 2021.

A systematic review is a specific technique which reviews all of the existing articles related to a specific research topic and evaluates the data, analyses, and contributions of articles, and synthesis them to report a conclusion on what is known and what is unknown about the topic (Denyer and Transfield, 2009). It tries to find out what literature inspires the practice of and reveals what is unknownto give a lead for future studies (Grant and Booth, 2009). There are six key phases in the systematic review as follows: "mapping the field through a scoping review"; "comprehensive search"; "quality assessment"; "data extraction"; "synthesis"; and the last stage is "write up" (Jesson et al., 2011: 108).

After determining the coverage period as 2008-2021, databases and keywords were selected. In this manner, the keywords: "blockchain and accounting", "cryptocurrency and accounting", "distributed ledgers and accounting", "smart contract and accounting" and "virtual currency and accounting" were searched for on the Scopus database. The categorization of the found studies according to their disciplines is presented in Table 2.

When "blockchain and accounting" was searched, 285 different studies were found. When the searchwas repeated with different keywords, such as "cryptocurrency and accounting" or "virtual currency and accounting", the results included the same studies obtained with other searches. By using the "savethe selected documents to list" feature of Scopus, the results of all keyword searches were integrated,and 334 different studies were listed. 108 of those 334 studies were in the "Business, Management andAccounting" discipline, and we focused more on them

Table 2

The Disciplines of the 334 studies listed by Scopus

Subject area	# of studies
Business, Management and Accounting	108
Computer Science	192
Economics, Econometrics and Finance	52
Engineering	90
Decision Sciences	57
Social Sciences	40
Mathematics	52

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Energy	32
Arts and Humanities	5
Biochemistry, Genetics and Molecular Biology	5
Materials Science	15
Multidisciplinary	3
Medicine	7
Physics and Astronomy	19
Agricultural and Biological Sciences	3
Environmental Science	11
Immunology and Microbiology	1
Chemical Engineering	1
Earth and Planetary Sciences	1
Chemistry	2
Psychology	1
Pharmacology, Toxicology and Pharmaceutics	2
Total	699

Source: Scopus

Because one study can be categorized under different disciplines, the total number of the studies from different disciplines increased to 699.

Table 3 shows the number of studies categorized under different disciplines. As mentioned before, the total number of different studies in "Business, Management and Accounting" discipline is 108, however because one study can be found with other keyword searches, the total number of the studies from different keywordsearches increased to 161

Table 3: *Number of Studies Categorized according to Disciplines with Different Keyword Search*

Subject area	**chain and account-ing**	**currency and account-ing**	**uted ledgers and ac-counting**	**contract and account-ing**	**curren- cy and account-ing**	**To- tal**
Business, Management and	92	18	25	20	6	161
Computer Science	172	19	34	43	5	273
Economics, Econometrics and	37	17	11	6	5	76
Engineering	84	6	17	22	2	131
Decision Sciences	54	4	11	7	3	79
Social Sciences	32	9	5	4	2	52
Mathematics	43	7	6	19	1	76
Energy	27	2	8	7	1	45
Arts and Humanities	4	1	1	0	0	6
Biochemistry, Genetics and	4	1	0	1	0	6
Materials Science	13	1	2	2	0	18
Multidisciplinary	2	3	0	0	0	5
Medicine	6	1	0	4	1	12
Physics and Astronomy	17	3	5	3	0	28
Agricultural and Biological	2	1	1	0	0	4
Environmental Science	11	0	3	0	1	15
Immunology and Microbiology	1	0	0	0	0	1
Chemical Engineering	2	0	0	0	0	2
Earth and Planetary Sciences	1	0	1	0	0	2

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Chemistry	2	0	1	0	0	3
Psychology	0	1	0	0	0	1
Pharmacology, Toxicology and	1	1	1	0	0	3
Total	607	95	132	138	27	999

The following figure shows trend of studies by year. The number of studies has started to increase since 2016. However, when we examine the percentages presented in Figure 2, we see that only 44% of the studies are articles published in journals and 43.7% are conference papers

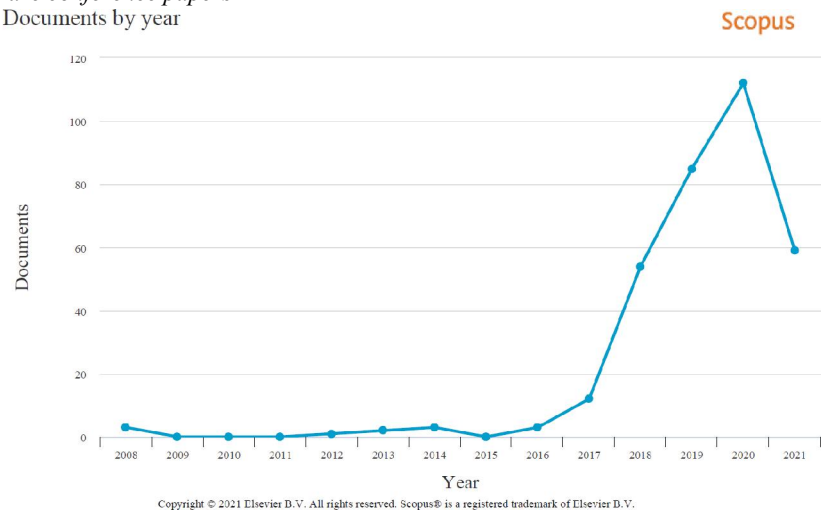

Figure 1. Search Results by the Year Source: Scopus

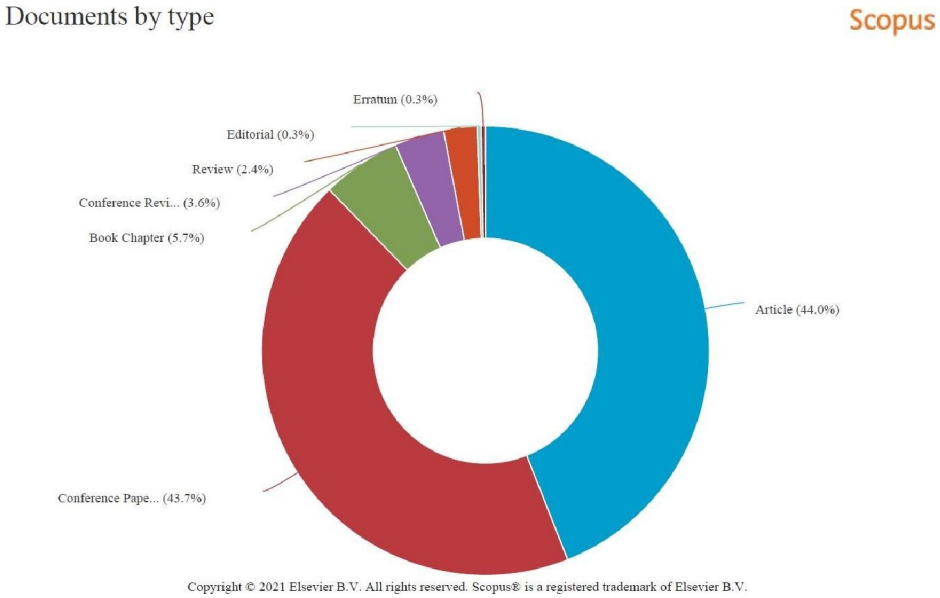

Figure 2. Search Results by Type Source: Scopus

After reviewing the blockchain and accounting literature, the first finding is that most of the articles are very technical, are written in the computer science area and the articles that try to connect BCT with accounting are struggling with

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inferences and possibilities rather than showing clear evidence and ways of using BCT in the accounting area. The studies in that area are at a very early stage and the answer to "how will blockchain affect accounting?" is up to the developmental stages in software programs connecting blockchain and accounting.

Integration of Blockchain with Accounting Information Systems

One of the most important studies that connect BCT with accounting belongs to Dai and Vasarhelyi (2017). They propose the use of blockchain as a medium for providing real-time, reliable, verifiable, and transparent accounting information to all related parties such as ma- nagers, auditors, creditors, and stakeholders. Real-time accounting and business monitoring can be provided with the integration of physical objects such as products, inventories, and production processes with the objects that have digital capabilities and have access to the Internet. Triple entry accounting, which has been suggested to increase the reliability and verifiability of the journal entries, can be realized with BCT because there is an opportunity to keep the entries in an independent and verifiable environment. BCT also enables managers to have "smart controls, which are computer programs that would operate on blockchain to automatically control business processes against pre-determined rules." Therefore, better control and assurance can be provided within a company with the third entries encoded into the blockchain (Dai and Vasarhelyi, 2017). According to Demirkan et al. (2020) and Kwi- linski (2019), BCT may have a destructive effect on the double-entry accounting system, and a triple-entry accounting system may replace it. Currently, Request Network, Balanc3, Led- gerium and Pacio are examples of the accounting software programs that use a triple-entry accounting system (Cai, 2019).

Weigand et al. (2020) argue that DLT may have a major impact on the existing accounting information system shaped by internal participants, not only because of the immutability and traceability of records but also because it may provide an external consensus view. They claim that as a result of the spread of blockchain-based shared ledger technology, the focus of financial reporting will change from a business-centric to exchange-centric model, and this will greatly increase the quality and reliability of financial reporting.

Dai and Vasarhelyi (2017) try to explain the processes in accounting while using BCT with a simple purchase and sale transaction. When the purchaser records inventory and ac- counts payable in its ERP system (or in its regular accounting system), at the same time the transaction information is encoded to blockchain in the form of a digital token. Each account will have a corresponding blockchain account (like Bitcoin wallet) that contains an account's unique identifier, current balance, and cryptographical keys for verification.

Bonsón and Bednárová (2019) name the blockchain environment of companies as the BCT ecosystem and divide it into two; the Company's BCT Ecosystem and Audit BCT ecosy- stem. In these systems, members operate as nodes. In the Company's BCT ecosystem, there are nodes for the company, suppliers, customers, banks, producers, investors, and the public administration and in the Audit BCT ecosystem, the nodes are public administration, auditors, and SEC. While creating an accounting information system in the blockchain ecosystem, the selection of nodes, the structure of the database, authorization, and verification protocols are very important aspects. After mentioning the design requirements, principles and features, Sogaard (2021) suggest governmental authorities use of BCT for the collection of value ad- ded tax receivables.

Blockchain is suggested as a management tool for supply chains by Dwivedi et al. (2020). High-value products or drugs need a more careful inquiry during the supply chain and block- chain may be a remedy for problems such as the tampering of products, delays, and fraud. They suggest using BCT with other technologies, especially with the Internet of Things, as an alternative to the ERP system.

When all the supply chain activities are followed by the BCT, integrating the accounting systems with blockchain will be inevitable. Calderon and Strato- poulos (2020) show the implementation of BCT in a supply chain. They explain the whole process of initiating, validating and recording a transaction on BCT in one of the segments of Listerine.

The faithful financial information, which is "complete, neutral and free from errors" as mentioned in the Conceptual Framework of IASB, can be provided with the integration of BCT in a supply chain (McCallig et al., 2019). Bakarich et al. (2020) argue that integrating BCT into supply chain management will provide benefits in collecting true and verifiable information for sustainable reports, and so, companies wanting to adopt BCT, should seek ways to integrate BCT and also provide sustainable reporting procedures.

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Based on an extensive literature review and from an organizational perspective, Tiron-Tu- dor et al. (2021) make a Strengths, Weaknesses, Opportunities and Threaths (SWOT) analysis of adopting BCT for accounting and auditing firms. Pimentel and Boulianne (2020) suggest the co-work and collaboration of academics and practitioners to have a better adoption pro- cesses. Roszkowska (2020) and Kwilinski (2019) claim that in the near future BCT may have a big role in accounting; many jobs such as billing, documenting, treating, registering bookkeeping, budgeting, and reconciliation might be done by autonomous programs based on BCT. These developments also have some implications for accounting and finance profes- sionals; BCT may change job definitions and responsibilities (Church et al., 2020). Consequ- ently, the content of accounting education should also conform to those new technologies and developments (Aldredge et al., 2020; Henage, 2020; Qasim and Kharbat, 2020).

Implications to Auditing

Auditors need to collect relevant and reliable evidence to form an opinion. Auditors face many challenges while verifying whether the records are complete and accurate and evalua- ting the accuracy of the data gathered. The blockchain system architectures that are suggested for use by CPA firms or auditors create benefit in collecting high-quality evidence about the financial data of customers while saving their privacy. Changelog was supposed by Vincent et al. (2020) as a system architecture that will benefit CPA firms and auditors while keeping the customers' information secret.

With the increase of BCT and smart contracts, auditing and assurance services may chan- ge fundamentally and a blockchain ledger can be used as a source document by auditors in the auditing processes (Dai and Vasarhelyi, 2017). Rozario and Thomas (2019) extend the discussion of Dai and Vasarhelyi (2017) on the possible applications of blockchain and smart contracts to transform auditing and they suggest an external audit blockchain that can support smart audit procedures. Because the transactions entered into the blockchain by the accep- tance of participating nodes, completeness, and accuracy checks are performed proactively, and blockchain attributes increase the integrity and reliability of the data. The information provided by IoT is also helpful in understanding the business risks of clients and the accuracy of auditors' estimates and valuations (Rozario and Thomas, 2019).

In the audit BCT ecosystem, cryptography can be used to design which node can see what information, so it can solve the privacy concerns of participants. Auditors can have continu- ous access to the ledgers of clients and so can make a continuous audit with BCT (Bonsón & Bednárová, 2019). McCallig et al. (2019) propose a system that will enable the use of block- chain in a supply chain for "accounts receivable" only. If the suppliers and the buyer firm have the same blockchain system, auditors may also participate in the system and can see the receivable balances of suppliers and payable accounts of the purchaser. In order to preserve confidentiality, the system will not allow suppliers to see the balances of each other.

Industry 4.0 has been accepted as the reason for changes in the auditing profession and it has created new tools and new processes for the auditing profession. Audit 4.0 includes audit activities by using the data created by artificial intelligence, smart sensors, and the Internet of Things (Dai et al., 2019).

Big Four audit companies also have a big interest in BCT. The number of projects ba- sed on BCT, cloud computing, artificial intelligence, machine learning, and IoT has been increasing rapidly and KPMG's Spark Project is one of them. It is a cloud-based real-time accounting system that integrates artificial intelligence and machine learning (Henage, 2020). Church et al. (2020) claim that cloud computing has been evolving for BCT based accounting information systems. Deloitte offered Rubix, which is a blockchain-based software program that allows users to make smart contracts.

KPMG developed its digital ledger services with Microsoft. EY works on Libra and Ops Chain for invoicing, pricing, digital contracts, and payments.

EY also launched Crypto-Asset Accounting and Tax (CAAT) software to assist US firms to report their crypto-asset transaction when filing their tax returns and Tattoo to track wine. PWC launched De Novo as a tool to implement BCT in supply chains (Bonsón and Bednárová, 2019; Bonyuet, 2020; Kokina et al., 2017; Schmitz and Leoni, 2019; Zemánková, 2019; Y. Zhang et al., 2020).

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The Need for New Regulations and New Accounting Standards

Blockchain has become popular with the increase in the demand for Bitcoin trade and it is used as a medium to record Bitcoin transactions (Bonsón and Bednárová, 2019; Bonyuet, 2020; Dai and Vasarhelyi, 2017). Bitcoin transactions have led to a new debate on how to account for digital money. While various definitions describe Bitcoin as "digital money" (Financial Action Task Force, 2014; Ron and Shamir, 2013) "what bitcoin exactly is" is still open to discussion. Is cryptocurrency money or an asset? Is it a product or an investment? The possible answers to those questions are debated in the related literature.

It is expected that the spread out of blockchain usage will lead to an increase in business transactions made with cryptocurrencies. However, the absence of legal regulations causes significant difficulties in accounting for cryptocurrency transactions (Sokolenko et al., 2019). Therefore, the need for an accounting standard on the subject is increasing day by day.

The main finding of the systematic literature review, conducted by Corbet et al. (2019), is that there are many gaps in the literature regarding cryptocurrency, such as; the potential benefits and uses of blockchain, evaluation of cryptocurrencies as part of a diversified port- folio, and legal, economic and regulatory issues. White et al., (2020) investigate whether the current regulations are applicable to cryptocurrencies. In that study, the behavior of bitcoin was examined with various methods, and it was found that Bitcoin mostly resembles a technology-based product. They concluded that current currency and security laws should not apply to cryptocurrencies.

Baur et al. (2018) research to analyze whether the Bitcoin is a medium of exchange or a (speculative) investment asset. Because one-third of Bitcoins are held by investors and a minority of users (both in number and Bitcoin balances) appear to use Bitcoin as a medium of exchange, they conclude that the main purpose of keeping Bitcoins is investing rather than using it as a medium of exchange. In addition to the classification of cryptocurrencies, their recognition and evaluation process are also uncertain. Morozova et al. (2020) state that there are four options for classifying cryptocurrencies according to the studies of specialists, professionals, and leading auditing firms: a) money, b) supply, c) financial asset, d) intangible asset. They also propose a prospective model for the valuation of crypto assets after initial recognition. Furthermore, the authors point out the need for a new IFRS standard for the ac- counting of crypto assets.

According to the 17 characteristics mentioned in Ram's (2015) study, Pelucio-Grecco et al. (2020) investigate the asset classes that suit Bitcoin's characteristics best within the framework of IFRS. They report that 13 characteristics of bitcoin are compatible with currency, 10 are compatible with financial instruments, and 7 are compatible with intangible assets. Therefore, they suggest that the most suitable classification and most faithful representation of cryptocurrencies should be that of a foreign currency.

Procházka (2018) evaluates accounting models for cryptocurrencies under IFRS. The aut- hor identifies existing models that may be used for cryptocurrency transactions and then compares competing models that are possible for a certain type of transaction. According to the study, there are three points to be noted regarding the model that can be used in accounting for cryptocurrencies: (1) the business model, (2) the purpose of the transaction, and (3) the expected decision-usefulness of the model.

THE CHALLENGES OF USING BLOCKCHAIN IN ACCOUNTING

Dai and Vasarhelyi (2017) classify the challenges of using BCT for accounting purposes under three categories: technological, organizational, and environmental. The stored data of Bitcoin transactions showed the need for larger storage systems if the data of other transac- tions are also kept in the blockchain systems. Would corporate blockchain streams quickly expand to an unmanageable size? What accounting data should be recorded in blockchain? and What other information (such as IoT data) should be loaded to blockchain in order to provide better assurance? are the important questions that should be answered in the techno- logical context. Investing in new technologies, the need for training of managers, employees, and auditors, the requirement for new regulations, new accounting and auditing standards are supposed as other challenges of BCT (Dai & Vasarhelyi, 2017).

The possibility of being stolen or loss of private keys of digital wallets, errors in smart contract codes, facing with a higher demand for auditing in a blockchain environment, higher computational power, storage capabilities, cybersecurity risk, litigation risk, the vulnerability of smart contracts, and regulatory acceptance of the use of

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blockchain are the risks of BCT that are mentioned by Rozario and Thomas (2019). O'Leary (2019) points out the lack of generalizability issues related to BCT.

Users of BCT should be aware that without the effective controls of IT infrastructure, the data provided by blockchain may not be reliable (Sheldon, 2019). P. Zhang and Zhou (2020) stress the importance of designing new consensus mechanisms to improve the security and trust of BCT. The increasing use of BCT may create a huge demand for employees who know about blockchain and other new technologies that have started being used in the accounting area. Therefore, the transformation of accounting education is also a challenge and necessity all over the world (Y. Zhang et al., 2020). Stratopoulos (2020) suggest the combination of storytelling and scaffolding approach to teach BCT to accounting students.

Abdennadher et al. (2021) made interviews with accountants and auditors in order to understand possible benefits and challenges of using BCT in accounting and auditing: diffi- culty in correcting mistakes, information overload, the need for new assurance services and stronger internal audit are challenges that have been mentioned by accountants and auditors.

II. CONCLUSION

Information technologies are developing very rapidly, and accounting information technologies are following those developments and changes very closely. BCT and cryptocurrencies are two of the current discussion topics in the accounting world. Although it has a history of about ten years, the

market cap of crypto coins is nearly $1.4 trillion. Moreover, the number of companies that accept payments with cryptocurrencies, the number of crypto money ATMs, and the number of users using cryptocurrency as a medium of exchange are increasing day by day.

Blockchain was a medium used to exchange Bitcoin at the beginning, however, different areas that the blockchain can provide benefit to have also been discovered. The finance sector is affected by

those developments most. Researchers from different study areas started to conduct research projects on BCT. Accounting is also one of the areas that are expected to be affected by BCT. Accounting academics, accounting journals, and accounting firms have an increasing interest in those new technologies in order not to stay behind those fast developments.

In order to foresee the potential effects of BCT on accounting, a systematic literature re- view was conducted in the current study. The articles found as the result of database searches are written mainly in the areas of computer science and accounting information systems. Articles in the computer journals focused on the development of BCT and how it can be mo- dified to be more useful in some selected areas. On the other hand, articles that try to connect BCT and accounting have very optimistic assumptions about the usage of BCT in accounting and most of them have the expectation of an accounting system fully based on BCT.

The clear point is that, with the increase in the transactions made by using Bitcoin and other cryptocurrencies, there will be an increasing demand to use BCT. However, the repla- cement of the current software programs with Blockchain is up to the developments in BTC and the elimination of its drawbacks. High costs, the need for hiring new personnel, difficulty in keeping the security of private information, new business risks, and a lack of regulations and standards are the main obstacles to the spread of BCT.

The contribution of this study is mainly to accounting regulators, professionals, and academics who want to follow the developments in BCT and its potential effects on accounting information systems. The study may help them to adapt to the changes more easily and foresee the potential risks and opportunities. Accordingly, necessary regulations can be made, new standards can be released, and the necessary education can be given to accounting professionals and accounting students.

Lastly, we want to make some suggestions for further research. Conducting case studies to examine the adoption and usage of BCT in accounting and auditing environment will be very valuable.

Searching the improvements in usage and adoption of BCT in accounting, internal control and auditing in a particular country setting, such as Turkey, conducting cross country studies and comparative studies between different industries will add much value to the current literature.