NEW ERA IN BLOCKCHAIN TECHNOLOGY AND BETTER ACCOUNTING INFORMATION*

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ABSTRACT

The magnitude of the potential blockchain has been so powerful that the way of doing business in all sectors could change dramatically. The nature of blockchain seems well suited to meeting the needs of accounting as well. If the potentials offered by blockchain can be fully realized, today's accounting practices are likely to change drastically in a way we have never seen before. In this study, it is tried to determine what kind of impact the blockchain holds for the future of accounting and auditing. "Decentralization" and "triple entry accounting" are revolutionary features blockchain could bring for accounting. In this study, it is understood that these changes seem theoretically possible, but not easy to use them effectively, because it turned out that there are many large and small obstacles ahead that had to be overcome before we could say full adoption of blockchain in accounting. It looks like there is a long way to go, at least for near future. However, considering the magnitude of innovative impact that blockchain will generate, it seems it is worth putting necessary effort in action to overcome these obstacles for high standards in accounting.

Keywords: Blockchain, Triple Entry Accounting, Smart Contracts, Accounting 4.0, Reliable Accounting Data.

JEL Kodları: M40, M41, M42.

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BLOCKCHAIN TEKNOLOJİSİNDE YENİ DÖNEM VE DAHA İYİ MUHASEBE BİLGİSİ

ABSTRACT

Blockchain'nin sahip olduğu potansiyelin büyüklüğü düşünüldüğünde, tüm sektörlerdeki iş yapma süreçlerinin bu yenilikten büyük ölçüde etkilenebileceği düşünülmektedir. Blockchain sisteminin, muhasebenin ihtiyaçlarını uygun şekilde karşılayabilecek bir yapıda olduğu da görülmektedir. Eğer blockchain ile beklenen değişiklikler sağlanabilir ise günümüz muhasebe uygulamalarının hiç görülmedik şekilde değişmesi söz konusu olabilecektir. Bu çalışmada, blockchain'nin, geleceğin muhasebe ve denetim faaliyetleri üzerine ne türden etkiler yaratabileceği belirlenmeye çalışılmıştır. Blockchain'nin getireceği "Üçlü kayıt sistemi" ve "merkezi olmayan yapı" muhasebeyi derinden etkileyebilecek devrimsel özelliklerdir. Çalışmamızda, bu özelliklerin teorik olarak uygulanmasının mümkün olduğu, ancak bunları etkin olarak kullanabilmenin ise kolay olmadığı anlaşılmaktadır. Blockchain'nin muhasebe alanındaki tam adaptasyonundan söz edebilmek için, çalışmada belirttiğimiz birçok küçük ve büyük engelin ortadan kaldırılması gerekmektedir. Yolun başında olmamıza rağmen, blockchain'nin yaratacağı yenilikçi etkinin büyüklüğü düşünüldüğünde, gerekli olan çabanın zaman içerisinde gösterilmesi ve ortaya çıkabilecek olan tüm sorunların ortadan kaldırılmaya çalışılmasının önemli olduğu açıktır.

Anahtar Sözcükler: Blockchain, Üçlü Kayıt Sistemi, Akıllı Sözleşmeler, Muhasebe 4.0, Güvenilir Muhasebe Bilgisi.

JEL Codes: M40, M41, M42.

1. INTRODUCTION

One of the most important financial crises was experienced in 2008. The impact went beyond Wall Street, and the financial crash was felt by everyone from America to Iceland to Turkey. This was when the idea for blockchain emerged, promising a more reliable system. The result was astonishing. This new method of record keeping has replaced the acceptable version of the truth with a more reliable one that we have never seen before (Thibault, 2018, 17-20). Blockchain technology draws so much attention and this subject finds place to itself in literature.

The trust is the most important element of the commerce. With blockchain, transactional trust can emerge in the most powerful way. It is even seen as the most important technology-driven invention after the introduction of the internet (CPA, 2016, 3). The World Economic Forum describes blockchain as one of top emerging technologies (Deloitte, 2017, 2). Blockchain system has a potential to offer efficiency to a wide variety of business processes (Fuller and Markelevich, 2020, 34). Blockchain was first meant to be a digital ledger to record transactions. However, new alternative versions of blockchain promise more than just a database; they can encode and execute any business logic within the blockchain (CPA, 2016, 3). Simply put, any entity which needs to have storage, verification, and secure access to any kind information might find blockchain as a solution. Currently it is used

mostly for recording and storing data for cryptocurrencies. But this seems to be just the beginning (Corkery and Popper, 2018). The blockchain system goes beyond just bitcoin transactions. It expands to include tracking contracts, financial records, public records and property ownership in the blockchain (Hoy, 2017, 273).

Blockchain and its application have been explored for usage of different business activities. Because of the inherent suitability of blockchain to the use of accounting transactions, it is important for accounting professions to understand the potentials offered by blockchain (George and Patakouskas, 2021, 2). Accounting can benefit greatly from blockchain technology. In addition, blockchain technology can also change the concept of traditional accounting drastically. Blockchain technology and smart contracts can be used to store accounting data safely, to distribute information between interested sides and to verify the accounting data. Blockchain can hold transactions of all type of property, shares, bonds, mortgages and others (Dai and Vasarhelyi, 2017, 9; Riumkin, 2017, 12). In the blockchain system, the company's entire ledger is instantly visible to all parties, including shareholders, customers, lenders, trade creditors and other interested parties. Any party can have all firm's transactions at any time in the form of any financial statement such as income statement and balance sheet. These parties will no longer have to wait for quarterly prepared financial statements by the firms and auditors thanks to blockchain system (Yermack, 2017, 14). There are still many problems for us to solve to pave the way for blockchain broadly used for accounting. Promising features are so groundbreaking. However, its full adoption seems to take time.

In this study, it has been tried to understand the potentials blockchain offers for better accounting information. It is tried to understand whether blockchain really offers life-changing innovations for better accounting information. In order to answer this question, it is important to understand the concept behind blockchain and which sectors would actually be affected. The impact of blockchain has been analysied on accounting and auditing and where the blockchain fell short to meet accounting expectations. Next, the challenges have been determined for blockchain to be used widely by all parties. It is obvious that the security and reliable authorization that blockchain offers exceeds the worries and keep people to feel hopeful for the future. Improvements needs to be made and some of them seem unanswered yet. But despite the uncertainties, more effort should be made because the offerings that blockchain suggest have the potential to completely solve the long-unanswered issue of trust.

2. THE CONCEPT OF BLOCKCHAIN

Blockchain is a technology which is based on distributed ledger. This distributed ledger consists of "chains" which are connected to each other. Multiple parties can view the content inside the block, but at the same time, what is inside the block are protected (Mc Comb II and Smalt, 2018, 1-2). Each transaction is approved by the participants in the system. Once entered, information can never be erased (Crosby el., 2015, 3). Blockchain distributes a ledger over the structure of connected computers rather than a single centralized system and keeps the record of all transactions since the very first transaction. Blockchain structure is copied and shared by the connected computers in the system. Whenever a transaction occurs, the new transaction is added to existing transactions as a "new block". New transactions are regularly added to the front of the blockchain, and whenever the new block is recognized by the majority of the computers, the blockchain is updated to reflect the accepted chain (Pilkington, 2016; CPA, 2016; George el.,2019,17; Fanning and Centers, 2016, 55). The blocks themselves are highly anonymized and encrypted. Transaction's headers are public, but they are not owned, and they cannot be changed by anyone. The headers are publicly available to those who desire to get detailed information about in transactions. However, they must have the wallet information details to do that (Huges, el., 2019). There are always sufficient number of participants available in the system to process the transactions (CPA, 2016; Jaoude and Saade, 2019, 360, 361).

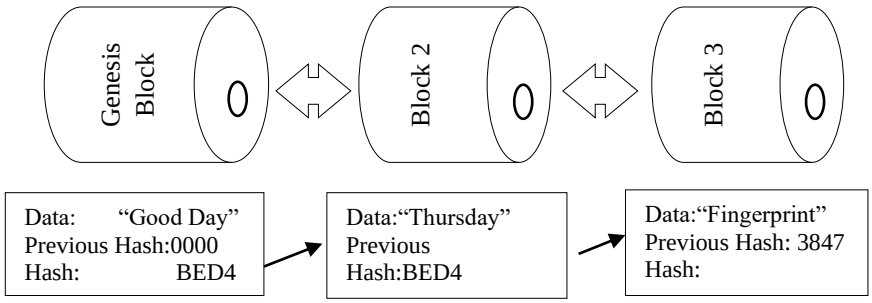

Figure 1: Blockchain immutability

Reference: (Kasthala, 2019)

As it is seen in Figure 1, blockchain immutability ensures that the chain of transactions can't be tampered with each other. Each block has immutable timestamps which indicate what happened before. In this way, the chain of transactions cannot be tampered with each other because each block references the previous block. If the previous block information is not correct, then the new block cannot be added. As a result, the blockchain

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cannot generate new blocks to the existing chain. Blockchain promises a stronger system than traditional IT infrastructures and is more reliable for attacks from malware and hackers (Huges, el., 2019; George, el,2019,17).

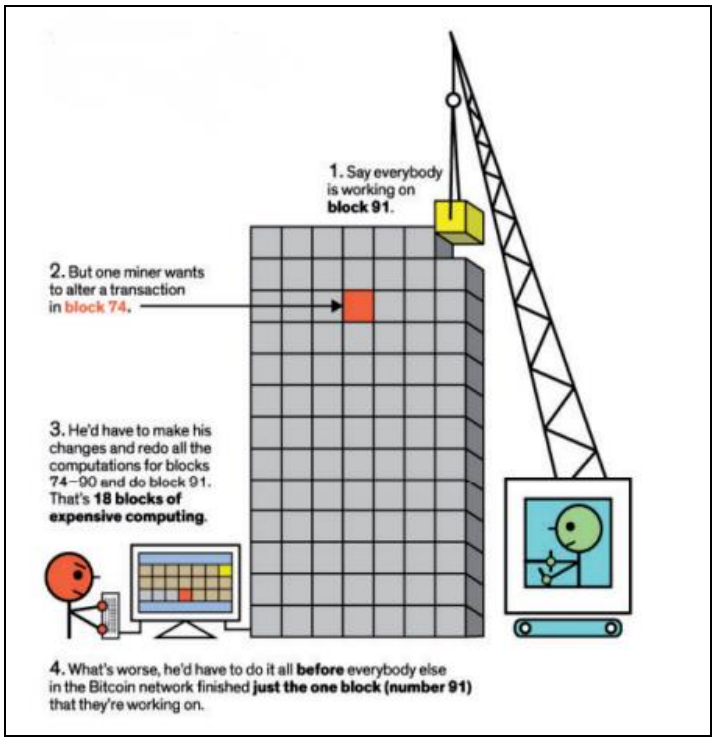

Figure 2: Logic behind blockchain secure data

Reference: (Peck, 2015)

As illustrated in Figure 2, let's say there is one block that a malicious miner wants to change for his own good, and it is block seventy-four and let's assume that the blockchain consists of ninety finished blocks and all computers are currently running on block ninety-one. If a malicious miner wants to alter seventy fourth block, he must do the necessary calculations to tamper with it and do the same calculations for all subsequent blocks, all the way from block seventy-four to block ninety-one. Since all blocks are interconnected and each block has the data of the previous one, if someone wants to interrupt the system, He or she has to change all the blocks up to the last one. Before new blocks can be generated, he or she has to reach block ninety-one to provide altered data to miners so that new blocks can be generated on this altered data. But in our example, this guy seems to be working alone and has very limited computing capabilites in the system. With thousands of computers working on new blocks, it is impossible for this single malicious miner to catch up. But if more than half of the entire computational power in the system is obtained, then it seems theoretically

possible to alter the chain (Peck, 2015). This threat, called the "51 percent" or "majority rule", seems to be possible but still highly unlikely. New adjustments are regularly made by the blockchain system to make it harder to find a winning hash by requiring more or less zeros in the hash of a new block. Processing time limit, currently around 10 minutes for generating new blocks, is an important factor to consider in making these regular adjustments. These all-regular adjustments not only make it very costly for miners to generate new blocks, but also make retroactive editing very hard, since even a small change in one of the previous blocks requires changing all hash codes of subsequent blocks. A malicious miner who wants to alter old blocks will face a tremendous workload of finding valid hashes for all subsequent blocks, up to latest ones. What makes it harder for this malicious miner is that honest miners will go on adding new blocks to the existing block, so it is very hard to make a change in the entire system. These difficulties explain why the information in the blockchain is referred to as "immutable" or "indelible" (Yermack, 2017, 14).

Distributed ledger technology, or in other words, decentralized system offers a significant innovation compared to traditional centralized record keeping. In sum, there are three main features which put new blockchain technology in a different place (Deloitte, 2017, 2; Jun el., 2017, 40; Bonyuet, 2020, 32):

- *Veracity*: Multiple copies of historical record in a ledger which were approved by majority of computers.
- *Transparency*: The system allows record of activities to be seen publicly by all participants in the system.
- *Disintermediation*: The core feature of blockchain is disintermediation. The traditional centralized system requires a third party, such as a bank, to act as an intermediary for the security of all transactions between two organizations. However, the distributed system eliminates the need for intermediares because there is no need for clearing agency. This is undoubtedly a very reliable and cost-effective way for both organizations.

3. THE MAIN CATAGORIES OF BLOCKCHAIN APPLICATIONS

The rapid development and progress has enabled blockchain technology to evolve over time. Swan (2015) discussed three tiers in his book called "*Blockchain: Blueprint for a new economy*". In addition, generation X was also discussed in the later part of his book which he thinks will be possible with the advancement in the blockchain technology (Fanning and Centers, 2016, 55);

- *Blockchain 1.0:* Blockchain logic is only used for all cryptocurrencies, including bitcoin. Cryptocurrencies are the first

implementation; therefore, it makes sense to categorize all cryptocurrencies as a first-generation blockchain. All applications related to cryptocurrencies are classified in this category.

- *Blockchain 2.0:* Blockchain is used by financial services and smart contracts are introduced. Smart contracts allow credible transactions to be executed without third parties. This includes different financial instruments including bonds, swaps, options and derivatives.
- *Blockchain 3.0:* Blockchain is used outside of the financial industry. It is used in different industries including government, health, media etc.
- *Generation X (Blockchain X):* This is the version of the blockchain where a public blockchain aims to be available to everyone, just like a search engine Google. It provides services to all walks of societies. This is a public open distributed ledger where rational agents make decisions and interact with other agents for the good of mankind.

4. THE USAGE OF BLOCKCHAIN FOR BUSINESS TRANSACTIONS

The financial sector is the first to see the potential in blockchain for business transactions. Blockchain technology allows cryptocurrencies to store value. Cryptocurrencies have the capacity to hold value and can be traded in their own market. Particularly after the 2008 economic crisis, with excessive money printing and injecting money into the financial system through open market operations, concerns about the depreciation of currencies have increased. At this point, the unique future of cryptocurrencies to secure the value of assets thanks to their limited number has become very attractive (Joo el., 2019, 717). In general, third parties are used to conduct financial activities among people and organizations. But with the invention of blockchain which provide confirmation, avoidance of duplication and validation of financial activities, the role of third parties has been replaced. For example, it was possible to make multiple payments with a total amount which is more than owed. But through blockchain technology, all financial activities will be verified by all sides before they are accepted. In addition, blockchain provides a secure registry for all financial transactions. This registry can't be modified by any entity after it is added to the blockchain. Blockchain can also be used to validate all transactions by multiple checks (Al-Jaroodi and Mohamed, 2019, 36502).

After financial sector, efforts have been done to adapt blockchain technology to other sectors (Ko, el., 2018, 4). Healthcare sector comes first (Agbo el, 2019, 2). Immutability of the blockchain is an essential factor which allows to secure health records and also ensures regulatory compliances. Blockchain can be used for real-time patient monitoring and medical interventions. Smart contracts can also be used in pharma by

developing measures against counterfeit drugs. Developing a new drug incurs a substantial cost associated with evaluating the safety and efficacy of the drug, the use of smart contracts allows to facilitate the procedure and improve identification management and data quality (Prokofieva and Miah, 2019, 4).

Green gas emissions are closely related to energy production and use. Human-produced carbon emissions are aimed to reach zero by 2050. Therefore, there is a big pressure on energy sector to reduce emissions and maintain energy affordability and security at the same time. Energy sector is undergoing a fast change to a decentralized, decarbonized, digitalized system (Ahl, el., 2019, 1). The renewable energy and decentralized blockchain promises efficiency for the future of energy. The blockchain can have many advantages such as cost reduction, process efficiency, effectivity. In order to guarantee transaction security, trading can be fulfilled based on identity verification enabled by blockchain technology. Blockchain also enables users to sell their energy more than they need to their neighbors or others. Middlemen are no longer needed in blockchain system as well (Rahmadika, el., 2019, 2). Increasing expectations from energy sectors are forcing centralized system to be replaced with a decentralized blockchain technology.

Supply chain covers many stages and locations, which makes nearly impossible for buyers and sellers to track properly all events and incidents happening all the way. Because of lack of transparency, prices also do not reflect actual costs of productions (Dickson, 2016). It is important to schedule, coordinate, monitor and validate all activities in the supply chain. Such functions can actually be carried out with blockchain technology. Decentralized blockchain technology will help reduce delays, management costs, and human errors for verification, storage and controlling logistic transactions (Al-Jaroodi and Mohamed, 2019, 36504).

Blockchain technology offers many advantages for government services including cost reduction, preventing fraud and errors, and transparency between government and other sides (Alketbi, 2018, 114). Blockchain technology is widely used by governments in various countries. Currently, 17 projects are carried out by governments. Such as in the United Kingdom (UK), the welfare payments system is based on concept of blockchain, in the United States (US) the government is currently working on an online personal health data exchange system. In China, the government is developing an asset storage system that carries the concept of blockchain (Negara el., 2020, 4).

There are three main areas where blockchain might help change in manufacturing industry. *First, the supply chain and logistics*; logistics management is extremely important for any manufacturer to ensure accurate

pricing and timely delivery (Al-Jaroodi and Mohamed, 2019, 36504). As explained before, supply chain and logistics are the areas where blockchain helps realize their potentials. Blockchain enables more transparency and accuracy for tracking the products and materials. *Second, the internet of things (IoT);* the blockchain technology could play an important role in future of IoT. Blockchain technology seems to have potential to improve IoT in so many ways. The distributed nature of blockchain provides protections and eliminates the attacks which happen in the centralized system in IoT. Blockchain can also solve the problem of identification and authentication of each device in IoT. Blockchain can provide a unique digital identity for each device and also helps each device stay updated with necessary information. *Third, the three-dimension printing (3D)*; 3D technology can help decrease the demand for storage costs by printing specific parts in a timely manner. Blockchain technology can play an important role in securing printing files and also tracks and verifies all specific parts (Soldner, 2019, 29).

E-agriculture helps to maintain market efficiencies, food safety and security and decreases uncertainty and risks. Using blockchain can help e-agriculture establish a higher trust among participants by providing a better platform to share their knowledge and utilizing e-agriculture services (Al-Jaroodi and Mohamed, 2019, 36504). Blockchain has gained a great interest from both consumers and producers for its contribution to food safety. Blockchain ensures transparency in supply chain and removes bad actors and poor processes. This ensures ideal conditions, from producers to end-users (Jain and Mishra, 2018, 37).

Entertainment platforms such as YouTube, Netflix act as distributers for video and music content. But there has always been the problem of payment between artists or content creators and platforms. Blockchain can help eliminate the intermediaries and let artists or content creators sell their products directly to customers (Soldner, 2019, 29). Contracts are used in all industries including entertainment sector. But the conditions on contracts are not always executed as they should be. Failure to protect the rights of all parties by a legal authority might cause the terms of contracts to be softened or changed. For example, the minimum amount specified in the contract might be transferred as high level to producers and editors. Smart contracts that blockchain can prevent such wrongdoings and distribute fair shares to producers, editors, distributors and consumers (Pons, 2017, 1).

Blockchain can function to keep track of a car's maintenance and sale history. This helps car manufacturers, car dealers and customers have more reliable and helpful information about the car itself. The blockchain can also be used for the future autonomous cars to perform transactions and payments. IBM and UBS companies have developed a "Car wallet" technology for this purpose (Soldner, 2019, 29). The blockchain technology

is also currently used to ensure the responsible sourcing of industrially-mined cobalt. Cobalt is mostly mined in the Democratic Republic of Congo under unacceptable conditions such as the use of child labor. Ford is working currently with IBM to enable ethical mining for car manufacturing through blockchain (Bajwa el., 2019, 8).

5. SMART CONTRACTS

The most important feature of blockchain is its potential to create "smart contracts". A smart contract is a computer program that can execute the terms of contract automatically. These little programs build the counterparty trust (Inghirami, 2019, 4). Smart contracts allow users to carry out an agreement on a blockchain in a verifiable way (Hanada el., 2018, 131). Many companies operating on blockchain technology has started to support smart contracts. Blockchain-based smart contracts eliminate the need for intermediaries such as banks and lawyers and execute the transaction immediately (Crosby et al., 2016, 14). For example, an exporter who sends invoice to a customer abroad waits from 30 to 90 days for the costumer to pay. But if they use "smart contracts", the smart contracts automatically pay when the customer acknowledges receipt of goods on the blockchain. In a different usage, the system can start the process based on the data from an external source called "oracle". For instance, a travel insurance company can automatically pay when it receives "data" from the airline company's records, namely "oracle", without waiting (George, et al., 2019,17).

6. INTEGRATION OF BLOCKCHAIN IN AIS

ERP (Enterprise Resource Planning) consists of computer applications designed to cooperate with each other for all transactions of the company. AIS (Accounting Information Systems) collects, stores and processes accounting data. Today's AIS has been supported by ERP technology and become stronger. Today's AIS provides both past and future financial information essential to accounting managers in their decision-making process (Daoud and Triki, 2013, 2; Inghirami, 2019, 8). Unlike a regular AIS running on a centralized system, the blockchain enables all transaction verification, storage and organization to be performed by a group of computers. This mechanism makes it hard for anyone inside to interrupt the system. This eliminates the risk of failure which is possible in the centralized system (Peters and Panayi, 2016).

Over time, two types of blockchain have emerged, namely public and private blockchain. In public blockchain, data can be reached by anyone who has internet access. On the other hand, in private blockchain, only certain parties have access to data. Government applications are mostly

based on public blockchain, so that all residences can access the information easily. On the other hand, in private blockchain, there is always a restriction on who should have access to data by an agreement. There are certain rules on how to access the information in private blockchain. Private blockchain is mostly preferred by companies which want to capitalize on the benefits of private blockchain but at the same time avoid the risk of extensive distribution of information (Bonyuet, 2020, 33). Public blockchain has some drawbacks. For example, it has a limited ability to process large amounts of information in a timely manner. Compared to the other payment systems such as Visa and Mastercard, public blockchain is slow. More importantly, companies may be concerned that confidential information may be vulnerable to leaking on public blockchain. On the other hand, private blockchain has usage restrictions such as what kind of privileges someone should have in accessing the blockchain or who should have access to the data on the blockchain. Because there is a limitation on the usage of the system for participants, private blockchain is considered to be partially decentralized. This might undermine the credibility and potentials of the blockchain. On the other hand, private blockchain has the potential to maintain privacy and is more suitable for the needs of company (Liu and Xu, 2019, 29).

Let's say company A and company B enter in a transaction together. Company A should make a payment to company B in euros. That is why company A should record the journal entry on the credit side while company B on the debit side. Public registry is created where two companies validate this transaction through signatures. Public record is integrated into the blockchain through previous and subsequent hashes (Fullana and Ruiz, 2021, 8). Using blockchain technology, companies can have new accounting information systems which record validated transactions on secure ledgers. Those kinds of transactions not only include monetary exchanges such as payments collected from clients, but also accounting information within a company. Such systems are nearly a real-time reporting through which accounting information can be distributed to all interested parties, for example, managers, auditors, creditors and stakeholders to review all transactions. Because of the dramatic decrease in costs of processing, storage and memory, all parties, including external parties, can access real-time accounting information at comparatively low cost. Smart contracts can act as an automatic controller based on predetermined rules. For example, once the limits determined in a smart contract regarding debt agreement are violated by a company, repayment or bankruptcy is automatically executed by smart contracts (Dai and Vasarhelyi, 2017, 9; George and Pataoukas, 2020, 18; Jun el., 2017, 12; Fuller and Markelevich, 2019, 35).

6.1. Triple Entry Bookkeeping in Accounting

Currently modern financial accounting is based on a double entry system. Discovery of this system dramatically changed the field of accounting. Double entry system can reduce the risk of human error, such as accidental deletion of transaction, but it doesn't provide comprehensive assurance for companies' financial statements. The company records all completed transactions and prepares the financial statements itself. Therefore, there is a risk of financial information being changed by a company to suit its interests. Auditors here act as third-parties to provide assurance on accuracy of the financial statements on a regular basis for government and stakeholders. However, each auditing exercise is costly and time-consuming, and unfortunately auditing cannot guarantee 100 percent assurance, because it is based on sampling. In other words, auditor does not collect all the documents produced in the accounting year to provide assurance, but instead, collects sufficient number of sample documents which can statistically represent the universe. Therefore, there is always an auditing risk, which means the auditor may give affirmative approval for financial statements which are in fact not accurate. For all these reasons, there is a need for a more reliable way to assure the financial statements (Cai, 2021, 75; Dai and Vasarhelyi, 2017, 9; Tyra, 2014).

The "triple-entry system" is suggested as a more reliable way of securing financial information. The blockchain technology is used to verify transactions by two parties and to be stored by a third party in a "triple-entry system". These records are shared with all parties to show if any changes or deletions have been ever made. All these processes can be automated, cost-effective and more reliable, because all transactions are decentralized by a third party (Inghirami, 2019, 7; Cai, 2021, 75; Dai and Vasarhelyi, 2017, 9; Tyra, 2014; Fullana and Ruiz, 2021, 6.; ACCA, 2020). The blockchain technology can act as an intermediary by distributing and automating the storage and verification process, providing a secure foundation that prevents tampering and irregular accounting entries. As explained before, once the transaction is approved by the majority of nodes, the new block is added to the front of the existing chain. The new entry is nearly impossible to be altered or deleted. Smart contract technology can be used to facilitate the process. All verifications can be done through smart contracts based on International Accounting Standards or other relevant business rules. Through third accounting ledger on the blockchain, a transparent, secure and self-verifying accounting information can be generated which can facilitate data sharing among all parties and continuous reporting for stakeholders (Dai and Vasarhelyi, 2017, 9; Tyra, 2014). The success behind the blockchain lies in the fact that each party in the blockchain database gets the same copy of the transactions. When there is a change in the records, the updated entry is shared to everyone. A business transaction between two

entities is recorded in this third-party public record. It is expected that, since all transactions are recorded in such a ledger, there isn't any need for intermediaries such as banks, at least on a theorical basis (Cai, 2021, 75).

Let's imagine the transaction between A and B to understand the innovation that triple-entry will bring. In a traditional double-entry system, there is a centralized structure to verify all transactions. Here in our example, A asks the bank to transfer money to B with a document. Once the bank authorizes the transaction, money is transferred to B from A's account. A and B update their entries accordingly. As explained before, there is always a risk of error and fraud in a centralized system. For example, one of the parties may knowingly or accidentally record the information of transaction incorrectly. Therefore, there is a desperate need for verification from auditors in a centralized system. On the other hand, in triple-entry accounting, A and B predetermine the rules and record these rules in self-executing digital contract. For example, A will pay B $100 if B provides the service. A and B sign the contract and this contract is kept in blockchain as a third ledger. Once the service is provided by B, two sides sign the contract again and the blockchain updates itself with this change. Then money is sent by the system to B (Cai, 2021, 75). The entries in the blockchain can be recorded in the form of token transfer between accounts. Accounts in the blockchain ledger can be formed in a regular order to aggregate data at various levels, which enables to see real-time accounting equation and also provides different views of information for different users. Token used in blockchain also serves as a proof for obligations or ownership of assets among parties (Dai and Vasarhelyi, 2017, 9). Auditor can easily access the necessary data through the blockchain and carry out most of the verification through blockchain, and this provides the auditor with the advantage of cost-efficiency, time savings and more reliable source of data (Tyra, 2014). However, it should be noted that blockchain itself cannot be the only reference for auditors (AICPA and CPA, 2017). Figure 2 illustrates money transfer between two parties based on smart contracts on the blockchain.

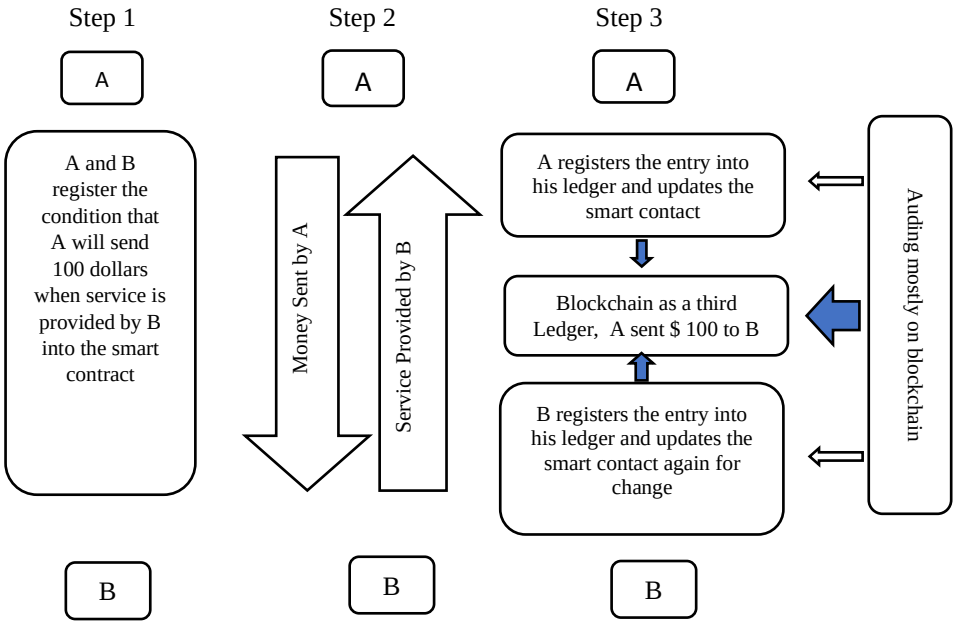

Figure 3*:* Triple Entry Accounting System

It is expected that the need for bookkeeping activities decreases over time thanks to blockchain technology. Especially, smart contracts is expected to reduce the work load of accounting professionals. Recurring activities with suppliers and customers can be easily managed with blockchain technology, such as firstly executing service and processing the invoice, then making the payment and producing the paid invoice. These automated steps are performed easily and accordingly with smart contracts. Therefore, repetitions and errors are dramatically reduced in this way (Desplebin, el., 2021, 12).

As explained earlier, using blockchain as a third ledger creates better verification and provides better security for all transactions. However, this revolutionary change brings many challenges with itself as well. All these promising changes are possible only if these challenges are dealt with wisely in the future.

6.2. Usage of Blockchain for Auditing

Auditors apply auditing standards and professional skepticism to make sure that reasonable assurance for financial statements is provided (AICPA and CPA, 2017). Blockchain, as a distributed ledger, can record all transactions in an efficient, verifiable and permanent way. Therefore, the blockchain can naturally serve as a reasonable source for verification in auditing process. For example, auditors can turn to blockchain as a third ledger to verify the

transactions, rather than asking clients for bank statements or sending confirmation letters to the bank (Psaila, 2017, 1). A typical audit relies on evidences which must be relevant, reliable, accurate and verifiable. The acceptance of the transaction in the blockchain may offer appropriate evidence for certain type of financial statement assertions such as occurrence of the transaction. Therefore, blockchain may not be able to provide all the necessary evidences to prove transactions due to the nature of the audit itself (AICPA and CPA, 2017). In other words, auditors will always be needed as a third party due to the nature of the complex system of auditing. For example, deciding what level of audit will be enough, how data will be obtained, what type of analytic methods should be applied. These are some of the decisions which an auditor should decide. In blockchain environment, the auditor may have different roles, such as, to make sure that the entity or the party which records the transactions on the blockchain actually exists or that the transactions in blockchain has economic substance (EY, 2017). Therefore, the auditor's role for verification on the blockchain might not be the same as a third party, but they are still needed to provide assurances (ACCA, 2020). Big accounting companies are closely following the developments and making huge investments to get the best usage of the blockchain technology for the future. They try very hard to find solutions to transform audit practices into blockchain-based applications. They want to solidify their positions in the market by being the first to use blockchain technology to full extent (Riumkin, 2017).

Adapting blockchain as a third ledger greatly reduces the time required to perform an audit. In this way, the auditor saves time and uses this time to concentrate on more important matters (George and Pataoukas, 2020, 18). The auditor can eliminate many of labor intensive and time-consuming works, such as manual data extraction and audit preparation activities (AICPA and CPA, 2017). Blockchain can help with transactional level assertions in an audit, and the auditor can focus on more meaningful questions such as how the transaction is recorded and classified. Such judgmental fundamental questions require detailed evidence, and most of time the blockchain cannot provide such evidence (ICAEW, 2018).

As illustrated in Figure 4, the blockchain-enabled audit consists of two main parts, the physical world and the mirror world. The mirror world is a virtual world which represents business activities and conditions of objects from the physical world. Each physical object has a virtual representation in the mirror world with the conditions, locations, surrounding environment, history and all other activities, and all physical objects have been transmitted to the virtual world through IoT or other information and communication technologies. The mirror world consists of three layers, blockchain, smart control and payment. The blockchain layer provides all

the necessary data required for auditing. It includes financial data from triple accounting information; records of physical objects transmitted by IoT, such as inventory and machines; non-financial information from outside, such as news and social media; systems log which stores real business processes. This data is protected and audit relies on it when performing advanced analyses. The smart control is a second layer which is based on smart contracts. Digitalized controls are performed by smart contracts. Smart contracts automatically execute the terms of the contract, which dramatically reduces the processing time and the costs of verification. These smart contracts operate on the top of the blockchain system and analyze the data to determine the risks, prevent frauds and support decisions. Last and third layer is the payment layer. Smart contracts monitor if the pre-determined conditions are fulfilled in the system. When the pre-agreed audit services are met, the system initiates the payment from the company to the audit firm (Dai and Vasarhelyi, 2017, 9; Yermack, 2017, 25).

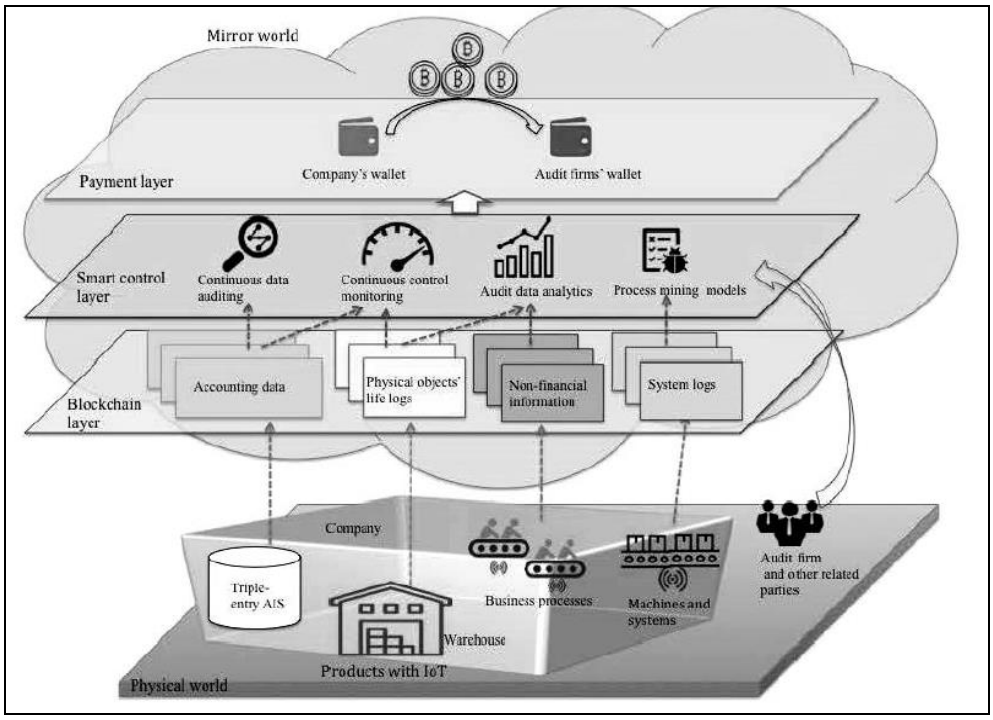

Figure 4: The Blockchain-Based Auditing

Reference: (Dai and Vasarhelyi, 2017, 9)

With the blockchain in place, but they should still be concerned about human errors and fraud to some extent (ACCA, 2020). In principle, blockchain is extremely secure. As mentioned earlier, each transaction on the blockchain is digitally recorded and only certain parties have access to the recorded data and all data is verified by majority users in the system. Having said that, there is always a risk of corruption from the majority of

the users on the blockchain (EY, 2017). The so-called "51 percent" or "majority rule" attack is one of the biggest threats to the blockchain system, in which erroneous information is introduced and then majority of the corrupted computers verify this transaction. Therefore, this erroneous transaction is added to the chain. Any group with 51 percent or more computing power can manipulate transactions this way. One way to prevent this is to keep blockchain private. The blockchain can be protected from the threat this way, but this time, the firm itself will have the power to modify the transaction as it needs (Bonyuet, 2020, 37). There is also a small chance that someone can interrupt the system. In June 2016, a Swiss based company lost around 50 million dollars after it discovered that someone exploited the system mistakes. Like any other system, blockchain also does not seem foolproof (EY, 2017). Therefore, no matter it is private or public blockchain, there seems to be always a need for auditors for verification process in blockchain.

7. CHALLENGES AHEAD

Regulations and organizational acceptance are still in their infancy for blockchain. But there is still a long way to go before blockchain is used more broadly in any application. We are not yet close to this. Despite the promising features, the blockchain has still so many challenges waiting ahead to overcome (Hughes el., 2019, 279). The challenges to the use of blockchain are tried to be explained below.

- One of the points where blockchain technology fails to respond is that it is considered to be used as a database engine rather than an application to transform data into useful accounting information. Currently, blockchain technology is based on a fairly simple business logic, mostly used to keep track of information, as in the case of bitcoin. Unlike current AIS, blockchain business logic has no space for accounting judgments and cannot generate an additional journal entry for accrual or capitalization. Therefore, blockchain seems to be too rigid to meet complex accounting needs. It seems like the accountant's role in judgement will still remain the same even in the blockchain-based AIS, at least for some time (Tan and Low, 2019, 315-316).
- In many companies, current validations in AIS require matching signed documents, starting with a staff member in any department of the company and ending with an accounting clerk. Therefore, validation process is prone to potential human error and fraud. The similar validation process might be necessary in a blockchain-based AIS, including validation by an accounting clerk (Tan and Low, 2019, 315-316). Therefore, the blockchain-based AIS is likely to

have a different structure, but all necessary parties will have to be authorized and other parties will simply maintain the records of the transactions. While error reduction and fraud prevention can mostly be achieved with blockchain, this does not mean that blockchain can guarantee 100 percent accurate and fair accounting information. Relying on blockchain system may result in other accounting risks regarding the controls over the information in that system. The role of accountants and internal auditors seem to remain important even in future blockchain-based AIS to assess the accounting risk about that information at least for near future (Fuller and Markelevich, 2019, 42).

- Security is still recognized as another challenge for the system and immaturity of the blockchain technology come with uncertainties. For example, there is no fraud department to report phishing attacks to take necessary preventive steps. The majority of computer power gained in the system has the potential to be the biggest vulnerability in security. Some even consider that this might pose a more important threat than the threats today's AIS faces. As the system is in the stage of taking the first steps to maturity, it is possible the system might be more vulnerable to cyber-attacks from outside parties willing to challenge the system (Ibanez el., 2021: 25).
- Another challenge is the cost and difficulty of bringing all related parties together. The system is only effective when all related parties are on the same platform. The system is new and complex; therefore, companies do not know what to expect. This makes them unwilling to make investment to adapt the system (Sinha, 2019: 66; Ibanez el., 2021: 25).
- Decentralization makes financial regulations difficult. Financial regulation is necessary for financial information to be reliable. At the beginning stage, people might have difficulties to understand and accept blockchain and it might be very challenging for them to evaluate financial information in the system. It sounds also difficult for regulators to lock in many anonymous accounts of clients and find out the whereabouts of funds (Chang el., 2020).
- Data privacy might be a concern for the companies to adapt the blockchain system. Allowing multiple copies of the ledger may cause companies to consider the possibility of losing their sensitive information. This is even particularly important for companies which operate in a more competitive environment. In addition to this, regulatory issues might be matter as well. For example, the GDPR (General Data Protection Regulation in European Union) aims to protect people's interest and their personal information. It requires that individuals should have access to their personal data. If possible, they can request correction and deletion of data at their insistence.

This may be a concern for blockchain-based accounting, given the fact that blockchain has no centralized authority and has an immutable nature (Fuller and Markelevich, 2020, 34).

- Blockchain has started to take its first steps in development and it seems like there is still a long way to go for full evolvement. One challenge that prevent blockchain's wide-spread adaption is the lack of a uniform standard on which blockchain accountants and other parties can rely. Accountants and interested parties want to build a system which produces reliable outputs, and all parties need to have a guideline on technical infrastructure as well as the management of the system (Sinha, 2019: 66).
- With blockchain technology, the tasks that accountants and auditors face seem to change over time, therefore they need to develop new skills. There might be a radical change in typical accounting education at academic level to meet this need. Academicians who are capable enough to follow new technologies seem to be needed at universities. This transformation might be challenging and takes time and effort. Therefore, developing skillful human resources seems to be another challenge ahead (Schmitz and Leoni, 2019, 340).
- Blockchain highly relies on internet. Therefore, improper infrastructure can result in hitches in the system. Companies should invest in the technological infrastructure to make sure that there will not be any obstacle for the system to function properly.
- Blockchain presents simpler structure compared to the typical AIS. Blockchain is based on a linear transactional database. However, typical AIS system has a relational database and allows all kinds of data operations which require an intensive and sensitive human effort all the time. On the other hand, Blockchain requires very little human effort with an automatic operation (Peters and Panayi, 2016).

8. CONCLUSION

All industrial revolutions have been directed by break-through inventions. Industry 1.0 was characterized with mechanization and steam power. On the other hand, Industry 2.0 was characterized with mass production and electricity. Industry 3.0 came with the invention of electronic, IT systems and automation. Currently, industrial era that we are in is Industry 4.0. Industry 4.0 is featured with new emerging technologies like IT technologies, cloud computing, machine learning, robotics, artificial intelligence and, last but not least, distributed ledger technologies. Distributed ledger technology, in other words, blockchain technology, seems to have potential not only to be the most standing and intriguing innovation of 4.0 era, but also to have the most promising features for nearly all industries.

Accounting looks like another area which also has the potential that blockchain technology can shape its future deeply. The promising features, such as distributed ledger or triple entry, sound so groundbreaking that the future of the accounting might need to be redesigned from scratch. In our study, we tried to identify if the blockchain technology actually has the capacity to shape the future of accounting as described. When we look at the literature, it seems there is a consensus over the potentials the blockchain holds for future of the accounting. But on the other hand, this revolutionary change is not easy to achieve. There seems to be many challenges to overcome to say full adaptation of blockchain for the future of accounting. There are even some difficulties with no clue how to handle them. Therefore, it seems it is not possible to use blockchain in the near future. Theoretically, what blockchain holds for the future of accounting is so valuable that these promising improvements blockchain offers will not be easy to give up. On the other hand, like all other changes, this kind of big revolutionary changes come at a high price. Among all other problems, the biggest problem seems to be the one that current version of blockchain is too rigid and rudimentary. Currently, blockchain can be used for storage. It is not capable to handle the complicated accounting issues such as impairment. This is because the capacity offered by smart contracts is so limited and only simple conditions can be embedded in the system. Auditing itself also requires some third-party intervention for the judgements of some data where the blockchain falls short. Questions that require personal judgment, such as what kind of analytical methods should be applied, are not something that the current blockchain can answer. Therefore, the accountant's and auditor's roles do not seem to change altogether. But seemingly, blockchain will have the role to assist the accounting and auditing professionals, which also can bring a big change for accounting. Even this level of role that blockchain offers for accounting does not seem achievable any time soon, not to mention full adaptation. Another big challenge ahead is that the blockchain is an emerging technology. Therefore, blockchain should be put in test before labeling the system as reliable for accounting. It seems like the subject is so new that we can't even imagine where the vulnerabilities might come from. Therefore, even though the blockchain system's most important quality is to offer a real assurance on accounting data, the system itself cannot guarantee 100 percent correct accounting information. The role of accountants and internal auditors seem to remain important even in future blockchain-based AIS to assess the accounting risk about that information. This is another reason why blockchain cannot be compared to current accounting practices at this stage. Blockchain seems to evolve gradually, and with each step, the role of auditing and accounting will change.

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