BLOCKCHAIN TECHNOLOGY AND IMPLICATIONS FOR ACCOUNTING PRACTICE

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ABSTRACT

Purpose *- The article discusses the possible implications of blockchain for accounting practice and what further developments are needed to create an integrated accounting system on blockchain technology. The focus is on both accounting and auditing.*

Approach *– The article follows a structure approach by identifying characteristics of blockchain technology to discuss the implications for accounting practice.*

Findings *- The instant verification and immutability features of blockchain systems provide for the integrity of data for both accounting and auditing purposes. However, the intensive use of blockchain for accounting information purposes depends on different and cheaper validation processes. The complexity of different accounting transactions with related estimates and uncertainty needs to be captured correctly on blockchain through use of interventions such as smart contracts without limited human invention to be successful. The so-called triple-entry accounting provides for the secure capturing of accounting information for use by different stakeholders, but currently does not change the double-entry accounting system to prepare financial statements. Confidentiality might become an issue with the real-time distribution of information among different stakeholders. Therefore, entities might opt for the use of private or consortium blockchain systems. Blockchain creates an avenue for continuous audit, but the independence of the auditor might be compromised.*

Value *– The article identifies the possible effect of blockchain on accounting practice and what further developments are still needed to create an integrated accounting system on blockchain technology.*

Keywords: Accounting, Auditing, Blockchain, Cryptography, Distributed Ledger Technology, Peer-to-Peer Networks, Smart Contracts, Triple-Entry Accounting.

INTRODUCTION

The literature identifies blockchain technology as a disruptive technology (Smith & Castonguay, 2020; Watson& Mishler, 2017). Christenson (2013) distinguishes between sustaining and disruptive technologies. The first is an evolution of existing technologies, while the second advances existing technologies. Blockchain is seen as a technology that will change the way that information is recorded, sent, received, stored and controlled, and will ultimately change the quality of information (Watson& Mishler, 2017). Currently, the view is that it would be easier for new businesses to be created on blockchain technology rather than existing businesses due to the disruptive effect of blockchain technology (Cong et al., 2018).

When Nakamoto (2008) created Bitcoin on blockchain technology, he created a specific peer-to-peer (P2P) payment system based on cryptocurrencies and not specifically a system that caters for the complexity of global accounting systems with multiple accounting transactions that are treated differently. Nakamoto's goal was more to deal with a specific problem of eliminating trusted intermediaries and replace them with digital verification in the blockchain system. Pertinent questions are how blockchain technology will disrupt

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accounting practice and how the quality of information provided through the accounting system could change from both internal and external reporting and auditing and assurance perspectives.

The objective of the article is to the discuss the possible implications of blockchain on accounting practice, both from positive and negative perspectives, and to identify what developments are needed to create an integrated accounting system on blockchain technology. The focus is both on the reporting and auditing of accounting information. In achieving this objective, the article first provides a short overview on the development of blockchain technology, after which different direct and indirect characteristics of blockchain technology are discussed to provide a view of the implications of these characteristics for accounting practice.

Historical Development

The concept of digital cash was first developed with the aid of a central server to prevent double spending about three decades before the idea of Bitcoin cryptocurrency was brought into the limelight in 2008 by Satoshi Nakamoto (Chaum, 1983). Nakamoto (2008) explained that there is a need for a system that will facilitate digital transactions without the aid of third parties such as banks, financial houses and stock exchanges. He further built his argument on the possibility of having a network of users that will be able to chain blocks of transactions with the aid of a computer network, internet technology and cryptography. According to Nakamoto, this network is decentralized and could be publicly available so that the participants will be able to decide and agree on a historical order in which the transactions were done and accepted. Some authors have identified blockchain technology to be a configuration of non-concrete data bonds together with an order of consistency conditions that identifies past events allowable on the distributed systems platform (Anceaume et al., 2019).

In his paper, Nakamoto did not mention the word '*blockchain*' but implied that the '*block*' in a blockchain is a block of transactions that has been broadcasted to the network and that the '*chain*' refers to a string of the blocks. Once the network validates a new block of transactions, it then becomes an addition to the end of the existing chain. Therefore, a blockchain could be referred to as an ever-growing list or ledger of transactions (chain of blocks) that have been validated by the trusted network (users) based on a single, agreed upon verifiable historical transaction. Bitcoin came into the limelight in the global financial marketplace because it adopted blockchain technology to establish a consensus mechanism based on the evidence or proof of work (Back et al., 2014).

The consummation of transactions and payments through fiat money will normally involve a third party aside from the payer and the payee. The traditional banking system usually acts as this trusted third party and has been referred to as '*go-betweens*' among the payers and payees (Rossi, 2004). However, with the introduction of cryptocurrencies, the trusted third party is done away with because the inclusion of a transaction in a blockchain ensures its finality, as well as its verifiability by many other participants in the blockchain (Dwyer, 2014).

The Bitcoin developed by Nakamoto was a form of electronic cash referred to as cryptocurrency based on blockchain technology. The security of financial transactions is ensured through cryptography. Cryptography is the process of ensuring that information transferred from a sender to a receiver is secured. Since the development of Bitcoin in 2009, more than 2000 other cryptocurrencies have been developed all around the world. Bitcoin is at present the most famous blockchain-based cryptocurrency. The applications of blockchain technology are nowadays not only used to effect online payments but also other transactions

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involving all types of digital assets captured as crypto tokens (Peters et al., 2015).

In today's world of trade, industry and commerce, the functionality of blockchain technology has extended beyond cryptocurrencies and other digital assets. For instance, Ethereum launched a digital payment and other applications system in 2015 based on blockchain technology with the aim of capturing different types of business systems on blockchain, more broadly than only digital payments and digital assets. The Ethereum blockchain has the capability of embedding agreements in a coding system for the automatic execution of contracts known as '*smart contracts*' (Kosba et al., 2016). In this way, Ethereum has extended the usefulness of blockchain technology beyond settlement of payments to commerce and industry as well as banking, finance and investment. Blockchain technology therefore moved to broader financial and business applications and ultimately to "*decentralised self-manging and monitoring models*" to create a "*more automated, flexible and efficient lifestyle"* (Dai & Vasarhelyi, 2017). The article focuses on this broader application of blockchain and the implications for accounting practice.

Main Characteristics of Blockchain Technology

In this section, we introduce the main characteristics or features of blockchain technology, such as: P2P networks; distributed ledger technology; cryptography; hashing and hash functions. Technically, blockchain is a chain of blocks, with each block having fields such as the block number, data or information, hash value of the previous block, hash value of the current block and the nonce. Each main characteristic is derived from literature and then applied to accounting and auditing.

Peer-to-peer (P2P) Networks and Blockchain Technology

As noted earlier, some form of digital money had existed before the advent of Bitcoin, resulting in several P2P networks being in existence for many years. For example, Sean Parker, who later became one of Facebook's founding executives, had created a famous P2P network known as '*Napster*', which was a file-sharing application (Carter & Rogers, 2014). However, the emergence of blockchain-based P2P networks signified an advancement on the previously existing P2P networks because it makes it possible for a large group of individuals or organizations to do transactions without the involvement of any single authority or third party either to record or validate those transactions.

Nakamoto's (2008) vision, on which Bitcoin was based, was to create a P2P electronic cash payment system under which payments can be sent to other parties in the blockchain without the need of financial intermediaries, such as banks. Nakamoto stated that digital signatures through cryptographical proof would replace the reliance on the trust of the financial and regulatory intermediaries. Information and funds could thus be transferred without the need for such intermediaries (Smith et al., 2019). Trust is thus placed on the integrity of the blockchain system for capturing both financial and other information.

The implication for both accounting and auditing is whether reliance could be placed on the integrity of the blockchain system and not on the trust of intermediaries and related regulators. The extent to which reliance could be placed on the integrity of the blockchain system depends on the discussion of the other characteristics of blockchain technology.

Distributed Ledger Technology (DLT)

Another notable characteristic of blockchain is that it is based on Distributed Ledger Technology (DLT). In this case, transactions are recorded and applied through distributed ledgers on different computers as against a situation where transactions are recorded on a

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standard ledger domiciled on a computer or server of a specific organization. For blockchain-based DLT, the distributed ledger is updated on a real-time basis on all the computers in the network. This means that every individual and organization in the network will also be able to see the transactions in real time. In simple terms, a blockchain is a form of decentralized ledger which operates on a P2P network. These distributed or decentralized ledgers are immutable because as a transaction gets registered on the distributed database, an immutable record of every transaction that occurs is kept, so that a complete audit trail of all transactions is created. In summary, a blockchain enables the real-time recording and updating of transactions in the distributed ledger once there is a consensus among the participants, without intermediaries. Hence, costs and time for executing transactions are considerably reduced through blockchain technology.

Decentralization resulting in information distributed amongst several computers is therefore a core characteristic of blockchain architecture (Dai & Vasarhelyi, 2017; Polyviou et al., 2019). Generally, just as in other value transfer systems which existed before blockchain, there are established rules for sending, receiving and recording value, but blockchain technology has made it possible for a higher level of decentralization of the network. Secondly, the blockchain-based cryptocurrency is said to be a modern value transfer system being operated through a public ledger platform. In a fiat currency-based economy, value is transferable through the currency (money) while in the crypto economy, value is transferred by means of an internet-based or virtual value containers referred to as coins or tokens. Thus, the primary function of a coin is to convey value between participants in the crypto economy.

Thirdly, the decentralized public ledgers such as Bitcoin involve great efforts from miners and their computer powers, which are rewarded with coins for these efforts (Evans, 2014). Rosenfeld (2011) conducted a study on the various incentive systems that could be used to reward miners in relation to their efforts. Lastly, the most distinguishing feature of blockchain technology is immutability, which means that the data are verifiable externally and cannot be easily changed by the participants or outsiders (Coletti, 2015; Derose, 2015b). This important feature has made cryptocurrencies stand out as a means of virtual exchange of value to date.

Smith & Castonguay (2020: 119) refer to a distributed relational database architecture (DRDA) that creates network-connection among stakeholders, which is in their view one of the "*most innovative and disruptive technologies*" that could be applied in the fields of accounting and finance. The distribution among different computers and the consensus mechanism reduce fraud due to eliminating one point of failure and therefore eliminating the possibility of data tampering (Dai & Vasarhelyi, 2017; Polyviou et al., 2019; Smith et al., 2019). These authors therefore see a blockchain as reliable, tamper-proof and authenticated.

The distribution of information is not only for the consensus mechanism of the validation of information, but also for the distribution of information between different stakeholders for faster and more efficient decision-making. The distribution of information among stakeholders creates new corporate governance and internal control considerations. Therefore, Smith & Castonguay (2020) respond that the governance and control procedures should not only protect the integrity of the entity's own data, but also how other stakeholders involved in the blockchain protect the data.

The distribution of information has specific accounting implications. The first is whether information is available to stakeholders and decision makers before it is captured and accumulated in the financial reports of the accounting system. Ultimately, both for internal management and external reporting, accounts will have to consider whether new ways of faster reporting of accounting information are available for better decision making. A related issue is whether such information, especially for internal management reporting, should be

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based on the requirements of existing financial reporting standards. The International Integrated Reporting Council (IIRC) (2018) has considered the information aspect regarding broader reporting. The IIRC proposes that entities should appoint a Chief Information Officer (CIO) who should be responsible for the capturing, analysing and providing of information for internal decision-making and external reporting. The IIRC believes that the CIO should work in collaboration with the Chief Financial Officer for both internal and external reporting. Accountants needs to be alerted that other disciplines will become more involved in reporting information and that an integrated reporting system needs to be developed in each entity.

The real-time distribution of information to both internal and external auditors also has major implications. This opens the door to more continuous audit procedures discussed further below. Smith & Castonguay (2020) specifically declare that auditors should assess the risk associated with a blockchain involvement when performing their audit.

However, the distribution of information amongst different computers and stakeholders also creates problems. It is costly, might limit data capacity and needs extensive computer power (Rozario & Thomas, 2019; Yu et al., 2018). The original blockchain development of Bitcoin uses the computer power of external individuals (miners), which could create confidentiality issues for big business, resulting in them not being willing to use public blockchains and therefore moving to private or permissioned blockchains (Coyne& McMickle, 2017; Yu et al., 2018). The miners are being compensated for their work through the issuing of cryptocurrencies. If the majority of big businesses are moving to a blockchain system of compensating miners for their work through cryptocurrencies, the value of cryptocurrencies could decrease, making the sustainability of cryptocurrencies as compensation for mining and related consensus procedures questionable. New ways of compensation for cryptographical validation might need to be developed before blockchain technology could become the norm for capturing and storing information.

The decentralized architecture of a blockchain involving a global network of computers running simultaneously on a software and validating a chain of transactions ensures that the record of transactions is not compromised and makes it difficult for unscrupulous insider players to beat the system and for outsiders to attack or break into the system. This has been referred to as the immutability characteristic inherent in the blockchain architecture. The immutability characteristic of a blockchain provides for integrity of data and therefore more reliable information (Kinory et al., 2020). The effect is that control systems will change (Smith & Castonguay, 2020; Smith et al., 2019), resulting in auditors considering reliance on the integrity of the blockchain system to develop their audit procedures (Dai & Vasarhelyi, 2017). However, Smith & Castonguay (2020) caution that dependence on the authenticity of the data that is captured in the blockchain could result in significant correction and reliance cost, if control procedure is not sufficient.

The real-time nature of a blockchain results in faster availability of information. Rozario and Thomas (2019) mention an improvement in the effectiveness of reporting and related auditing thereof. Faster real-time reporting could be for both management and financial statement reporting. Coyne & McMickle (2017) refer to a more secure alternative for current accounting, but express concerns whether a blockchain could capture all the complexities of current accounting systems. The system should capture accounting procedures in the blockchain system for multiple accounting systems to achieve the correct treatment for all different transactions and the related presenting and disclosing of the accounting information correctly. Currently, the blockchain system might be an input to the accounting system, which could even be supported by different blockchain systems for different transactions (Gomaa & Gomaa, 2019; Qasim & Kharbat, 2020). Therefore, Dai and Vasarhelyi (2017) declare that, currently, a blockchain has the potential to play a part in the accounting information system or might be used in conjunction with it. Several developments

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still need to happen before a blockchain will become the norm for an integrated blockchain accounting system for major businesses, if ever. Transformation from current accounting systems might be slow and blockchain accounting systems might be used more by new businesses developed on blockchain system.

From an audit perspective, a blockchain provides a more secure audit trail (Dai & Vasarhelyi, 2017; Rozario & Thomas, 2019; Smith & Castonguay, 2020) and real-time access opens the door for continuous audit procedures (Dai & Vasarhelyi, 2017; Cong et al., 2018; Kinory et al., 2020). Cong et al (2018) refers to both continuous assurance and monitoring functions. The literature therefore suggests that the current audit or assurance paradigm might change significantly (Dai & Vasarhelyi, 2017). Smith & Castengauy (2020) state that timely and reliable audit evidence must be balanced against the testing of the blockchain-related internal controls, which could be costly the first time the blockchain system is applied. A proper assessment of the internal control system and information technology controls is still needed (Gomaa et al., 2019). They, however, caution that the real-time access might not provide all evidence needed for audit purposes and that management assumptions and estimates will still need to be assessed. Blockchain application will also not prevent all fraud and errors (Yu et al., 2018).

Cryptography, Hash Function and Blockchain Technology

All blockchains have built-in cryptographic functions, which are capable of tokenizing and tracking any asset digitally in a secured manner (Es-Samaali et al., 2017). The assets could then be traded interchangeably with any other assets across countries in real time. The private or public signature technology enables blockchains to be cryptographically secured and therefore the transactions created are not susceptible to fraudulent practices. The science of cryptography, through cryptographic techniques, ensures the protection of sensitive personal, institutional or organizational information, which may be in the form of communication between parties or as storage of processed information (Saper, 2013).

Cryptography enables each participant to be assigned a private key and at the same time a public key, which is shared with all the other participants. While private keys are in the form of secret passwords, public keys are addresses that have been cryptographically generated and stored in the blockchain. There are presently several cryptographic concepts being used in the blockchain; many others, for example, CryptoAPI, are yet to be fully applied in order to increase the effectiveness of blockchain solutions (Raikwar, 2019; Wang et al., 2019). A future owner of a digital token (coin) can initiate a transaction by forwarding his or her public key to an initial owner. The coins are then transferred through the digital signature of a hash function. Every coin in a blockchain has an address associated with it and consequently every blockchain transaction will involve an exchange of coins between one address and the other. Although the transactions in a blockchain are enabled through the public keys and are traceable, the identities of the participants are not disclosed. This makes blockchain transactions more safe and secure when compared with transactions through normal fiat currencies of countries all over the world.

Coyne & McMickle (2017) state that a blockchain creates both distributed transaction verification and identity verification. The public keys create the transaction verification and although these keys protect the identification of the transaction parties, the nature of the transactions is publicly available. Transparency of the blockchain system is created, which in the view of Yu et al. (2018) could improve the quality of external reporting and reduce information asymmetry. However, due to the confidentiality issue, as previously discussed, certain businesses might choose not to use public blockchains.

Private keys protect each user of the blockchain. However, private keys could be lost,

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which makes them untraceable and holders thereof would lose the benefits. Private keys could also be stolen or hacked outside the blockchain system; thus secure safekeeping and storage of the private keys by holders and other participants is needed.

The use of public and private keys in a blockchain also prevents double spending, which is not a major problem with fiat currencies because they cannot be replicated with ease (Morhaim, 2019; Pilkington, 2015). Double spending is when a cryptocurrency or other crypto token is used more than once to pay for or facilitate different transactions. Nakamoto (2008) originally developed the cryptographic verification to prevent double spending; prevention of double spending is a key feature of blockchain systems.

Thus, a blockchain can be referred to as a chain or record of transactions, which is continually updated by participants (known as miners), who engage themselves by providing solutions to complex computational problems. Through their activities, the miners normally produce additional blocks to the blockchain for which they are rewarded with newly minted coins as block rewards. The miners' rewards are added to their public addresses. The increase in the mining power in the blockchain system will lead to more complex problems needing to be solved before a new block can be mined (Böhme et al., 2015). There has been advancement in mining techniques with the introduction of mining chips, such as Bitshares, in several internet devices to mine new coins. Also, the introduction of the first Bitcoin computer, known as 21 Inc., seeks to advance mining technology (Srinivasan, 2015).

Fundamentally, a blockchain provides information on either monetary or economic transactions. This is achieved by means of hashes and hash functions. A hash is an output resulting from the conversion of an original piece of information, known as input, by means of a mathematical algorithm known as a cryptographic hash function. A major characteristic of a cryptographic hash function is that it is very difficult to reverse once it has been applied in a blockchain transaction (Rahmadika et al., 2018). The validity of a block is achieved when it hashes to a value which is less than the current mark. Also, for a new block to be accepted, there must be a cryptographic proof-of-work in such a way that each new block recognises the previous actions taken in the process of producing it. For instance, Bitcoin cryptocurrency depends on a cryptographic hash function known as double SHA256 hashing algorithm, with an extremely large target of 256-bit being shared by all the users of Bitcoin (Pilkington, 2015).

The feature of cryptographic proof-of-work is the verification of transactions in blocks which paves the way for removing intermediaries. Therefore, a blockchain provides the ability of increasing the verifiability of accounting data and of sharing the data with different stakeholders in real time (Dai & Vasarhelyi, 2017).However, concerns are expressed whether the blockchain verification could be used for accounting purposes (Coyne & McMickle, 2017). Their argument is based on three reasons: (1) extensive accounting knowledge is needed to capture transactions correctly for accounting purposes; (2) control is still required to ensure and protect the accuracy of the accounting entries; and (3) accounting is more complex than only transferring assets. They also believe that proof-of-work might not be efficient due to high processing and electricity power. The future of verification of information for accounting purposes through proof-of-work or any other future means of verification is subject to the ability of the verification process to capture different accounting transactions correctly for accounting purposes.

The capturing of validated information in blocks is the basis for continuous auditing and a view is expressed that continuous auditing might first start with internal auditing due to a better understanding of and closer involvement in the systems of the entity (Cong et al., 2018). Information could then be distributed through the blockchain system to the auditors as soon as the information is available. However, most entities are currently not on a blockchain ecosystem, and so long as certain information is still captured in traditional accounting

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systems, continuous auditing will be less achievable.

New Crypto Economy

The use of cryptographic techniques has given rise to what is called the '*crypto economy*', described as the system which uses cryptographic methods to monitor behaviour instead of using intermediaries that are not defined by demography, political or legal systems (Babitt & Dietz, 2014). Thus, a discipline known as crypto economics, which studies the design and characteristics of procedures for the development and delivery of goods and services in a decentralised digital economy, has evolved (Pilkington, 2015; Zamfi, 2015). Institutional crypto-economics has also been used to provide solutions to the problem of information in world trade indicating that blockchains will lead to changes in the form and dynamics of global trade in future (Allen et al., 2019).

The discussion so far and the literature agree that blockchain technology would change the accounting landscape (Qasim& Kharbat, 2020). Dai & Vasarhelyi, (2017: 9) went further to state that the current accounting paradigm might change due to emerging technologies; they refer to a "*blockchain-based accounting ecosystem*" under which accounting information is initially verified, securely stored and is available in real-time for decision-making and reporting. We are, however, far from such an accounting ecosystem and only entities that are part of crypto economics might currently take advantages of such a system. Rozario & Thomas (2019) therefore believe that the blockchain ecosystem consists of several interlinked blockchain systems and that accounting systems might still be separate from the blockchain ecosystem. Notwithstanding, they confirm that the immutable feature of a blockchain is an important advantage over traditional accounting systems and concur that accounting systems will change over time.

The literature also agrees that blockchain technology will bring changes to the auditing landscape. In a blockchain ecosystem the auditor will be able to access the blockchain information in real time, making the audit process less disruptive for management (Rozario and Thomas, 2019). The achievement of the integration with auditing smart contracts, as discussed later, will play an important role.

Private, Public and Hybrid Blockchains

Private blockchains are characterised by private distributed ledgers where a central team of decision makers exists to monitor written permissions, while at the same time the readable permissions are either restricted or made public (Buterin, 2015). A private blockchain is characterised by a permissioned ledger, while public blockchains are characterised by public decentralized ledgers that are accessible to everyone who desires to participate. In other words, participation is free as there is no condition attached to participating in the process of creating or adding blocks to the chain (Buterin, 2015). In a fully decentralized blockchain, validation is based on the mechanism of consensus and the proof of work. The Bitcoin is an example of a fully decentralized blockchain where the chain with the most proof-of-work is taken to be the valid chain (Swanson, 2015).

Uncontrolled outside participation, compensation of miners and the confidentiality concern were previously identified as reasons why businesses might not implement public blockchains. The view in the literature is that businesses will therefore choose to implement private blockchains (Coyne & McMickle, 2017; Yu et al., 2018). The benefit of public proof-of-work might be lost and therefore an alternative means to blockchain verification might be needed (Yu et al., 2018). A blockchain platform such as Ethereum is already considering alternative ways to validate transactions and the future evolvement of blockchains for business and accounting purposes will focus on how cost-effective consensus and verification

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measures could be developed that also protect the confidentiality of information.

Polyviou et al. (2017) believe that new forms of verification will affect internal control procedures and the integrity of the information stored in the blockchain. This will also affect the reliance of auditors on the integrity of the blockchain system. However, Coyne & McMickle (2017) identified that two layers of control are added to private blockchains, which make it more applicable to accounting systems: (1) privacy; and (2) permissioned access. Privacy features overcome the confidentiality problem by protecting the privacy and confidentiality of data (Dai & Vasarhelyi, 2017), while the permissioned feature controls the degree of access stakeholders have to the blockchain database. Therefore, in private blockchains, central authority and related procedures are included to monitor and control the access of stakeholders (Dai & Vasarhelyi, 2017). Gomaa et al. (2019) went further to state that a third-party blockchain assurance provider could be used and specifically blockchain-platform entities, such as Ethereum, develop and monitor blockchains for the benefit of their clients.

The benefit of blockchain technology is that the information could be shared among different stakeholders (Kinory et al., 2020). The participation of the auditors, both internal and external, creates the possibility of continuous auditing in real-time (Dai & Vasarhelyi, 2017; Cong, Du & Vasarhelyi, 2018).

This also has implications for governing boards of entities, which need to decide how much oversight they are sharing and how much control they are maintaining (Smith & Castonguay, 2020). These researchers (2020: 123) are of the view that these decisions are based on the concepts of "*interconnectivity and share trust*" between the stakeholders.

It is important to note that the degree to which a blockchain is designed to ensure anonymity of the participants and the degree of decentralisation are the relevant points to consider when differentiating between private and public blockchains. Thus, between the private and public blockchains, there exist other variants such as partially decentralised blockchains which are said to be a variant between the public and the private blockchains. This form of blockchains has also been referred to as 'consortium blockchains' (Buterin, 2015b; Allison, 2015; Brown, 2015).

Consortium blockchains combine the protected access of private blockchains with the distributed nature of public blockchains (Sheldon, 2019; Smith & Castonguay, 2020). More than one entity are thus working together to create a combined blockchain to share data among entities (Cong et al., 2018). Shared governance structures and control mechanisms are then required (Smith & Castonguay, 2020). The audit implication is that, in auditing a specific entity, the auditor needs to evaluate the control systems of other entity participants to rely on the integrity of the blockchain system.

Smart Contracts

Smart contracts are an important feature of private blockchains. The functionality of smart contracts is to execute predetermined procedure in the blockchain system if certain conditions are met. This is a very important step in the future development of blockchain systems. Coyne & McMickle (2017) are of the view that smart contracts provide additional protection for the parties to different transactions. However, this has further control and auditing implications. A control system of monitoring the implementation and changes to smart contracts is also needed (Yu et al., 2018).

Smart contracts could be used for different reasons by accountants. Through smart contracts accountants could also implement control procedures and certain transaction verification procedures (Dai & Vasarhelyi, 2017). To make blockchain system accounting functional, accounting standards could be incorporated in blockchain systems through smart

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contracts (Dai & Vasarhelyi, 2017). Accounting functionality is a major concern that needs to be discussed in the blockchain literature, which brings us back to the complexity of accounting systems and whether the blockchain validity process could cater for such complexity.

Auditors, as a stakeholder in the blockchain system, could use smart contracts to obtain and analyze audit data from the system (Rozario & Thomas, 2019). Auditors therefore need to be part of the design and implementation of the blockchain system (Dai and Vasarhelyi, 2017), which could compromise the independence of the auditors. Accepting the verifiability of the blockchain data through the integrity of the system will, however, place more reliance on the judgements and skepticism of the auditor (Dai & Vasarhelyi, 2017). The literature speaks to smart audit procedures using the benefits of blockchain, smart contracts and other emerging technologies (Dai & Vasarhelyi, 2017, Rozario & Thomas, 2019). Dai & Vasarhelyi (2017: 15) refer to a "*mirror world*" based on blockchain technology, smart control and smart contracts. Another view is that future auditors could create their own external audit blockchain to capture audit information (Rozario & Thomas, 2019).

Triple-Entry Accounting

The literature confirms that by using the blockchain technology the possibility of triple-entry accounting is created (Coyne & McMickle, 2017; Dai & Vasarhelyi, 2017, Kokina et al., 2017; Watson & Mishler, 2017). The argument for this assertion is that each transaction is cryptographically verified and recorded in an immutable block in the blockchain, which provides information of the seller and the purchaser, although they will be protected through the public keys (Watson & Mishler, 2017).

Before we get excited about the possibility of triple-entry accounting, it is important to compare this development with the current banking system. Currently, in the banking system an individual or entity's transactions are recorded in their bank account, which is a record that is kept separately and independently by the bank. The bank statements received from the banks are used to do a bank reconciliation to the related accounting ledger account. The difference under a blockchain is that this third entry is secured though the consensus system in the blockchain and no reliance is placed on trusted third parties that could be compromised.

Therefore, there is no evidence that the financial reporting system that we currently use will move away from a double-entry system to prepared financial statements. A blockchain is, in essence, only a system that securely records transactions and related information in real-time. The possibility, however, as discussed further under other technologies below, is that accounting information might be analyzed and presented differently by using data analytics techniques.

In this regard, Kokina et al. (2017) specifically highlight that the double-entry system has not changed in the computer and digital age, which leave it still vulnerable to traditional inefficiencies and risks. The benefit of the blockchain system is that the transaction is recorded in a separate immutable ledger that improves security and validity (Coyne & McMickle, 2017; Kokina et al., 2017; Mancha & Pachamanova, 2017; Watson & Mishler, 2017). The literature agrees that the independence and security of the blockchain technology could improve the reliability of financial statements (Dai & Vasarhelyi, 2017; Yu et al., 2018). Dai & Vasarhelyi (2017), as previously stated, refer to a "*self-sufficient accounting ecosystem*" that provides information immediately to different stakeholders. However, they caution that blockchain development is currently not sufficiently advanced to deal with multiple different transactions verification and correct recording.

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The view of Gomaa et al. (2019) currently holds that transactions are recorded in the blockchain system, but separately in the traditional double-entry accounting system of the parties involved in the blockchain transactions. Only in limited instances where an entity's total recordkeeping system is on blockchain, such as new companies formed on blockchain, and integrated exists into the accounting system that directly produce the financial statements. Yu et al. (2018) believe that through blockchain technology, accounting choices and judgements could become more transparent and that correspondingly this could result in increased comparability of accounting information.

Blockchain and Other Technologies

The literature, as discussed below, agrees that blockchain developments may not be separated from other new technological developments. Firstly, a blockchain can be used in combination with big data so that it can serve the purposes of data analytics and data management (Zheng et al., 2017). Dai & Vasarhelyi, (2017) propose that data analytics can be used in conjunction with blockchain technology to identify anomalies and present related information. Watson & Mishler (2017) agree that blockchain technology could be used to improve information applications. Moreover, because of the security of the distributed data in a blockchain, the integrity of the data is protected, particularly in the case of sensitive personal (e.g., patients' information) and organizational (e.g., customers' information) data.

Secondly, a blockchain could also play a role in the Internet of Things (IoT). (NRI, 2015; Atzori et al., 2010). Under IoT, computers, machines and other devices send out information under certain conditions that form part of information that is available on the internet. Dai & Vasarhelyi (2017) propose that smart contracts could be used together with IoT technologies for capturing information from electronic devices to create digital recording on a blockchain. Cloud computing could also play an important role in storing such data (Cong et al., 2018).

As artificial intelligence, machine learning and robotics take over some functions of accountants, the way in which accounting information is captured should also change. The real-time ability of a blockchain makes the integration of such technologies possible. The literature therefore agrees that accounting and auditing would change dramatically due to the application and integration of these technologies (Dai & Vasarhelyi, 2017; Cong et al., 2018; Watson & Mishler, 2017). The application of continuous auditing is made possible through the integration of artificial intelligence (Cong et al., 2018).

CONCLUSION

The objective of the article is to highlight the possible implications of blockchain for accounting practice, from both an accounting and an auditing perspective. Questions addressed are whether the accountant and auditor will be able to rely on the integrity of the blockchain system based on new governance and control systems and whether the accountant and auditor could accept the authenticity of the captured accounting data.

The instant verification and immutability of data through cryptography functions provides for the integrity and reliability of data and caters for the removal of the function of intermediaries with related cost savings. However, the proof of work verification might be costly because of extensive computer power and limited data capacity, and the continued compensation of miners through cryptocurrencies might become burdensome. The intensive use of blockchain technology for business and for accounting system information purposes might depend on different and cheaper validation processes.

The distribution of information to different stakeholders through the decentralization feature of blockchain technology creates for the real-time availability of data for different

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stakeholders. However, this could create confidentiality issues regarding shared data. This interconnectivity and shared trust should be considered by accountants and auditors when assessing the related control environment and integrity of the blockchain system.

Real-time capturing also creates faster availability of data for decision making, which could improve the effectiveness of information reporting and the related auditing thereof. New ways of data analyses through artificial technology techniques could further enhance the information capabilities but will also bring in other disciplines that are analysing the related information. The issue is whether the complexity of different accounting transactions could appropriately be captured in a blockchain system and the effect might be that the integrated accounting system of existing entities might for the foreseeable period be kept separate from a blockchain system and that blockchain systems might be used only for specific functions in entities. The future use of blockchains in accounting systems is dependent on the development of such integrated accounting systems.

The literature is, however, foreseeing that the accounting ecosystem will change. The initial verification, secure storing and real-time availability and further analysing of date will change decision making and reporting practices. Accountants and auditors will need to understand the capabilities of analysis and presentation of data and how this will affect accounting and audit practices. It is hoped that better transparency could improve the quality of reporting and therefore reduce information asymmetry. The question is whether big business will be amenable to open transparency.

For confidentiality of information reasons, big business might opt more for private blockchains where the privacy and permissioned access is controlled. This could protect the anonymity of stakeholders and determine the degree of decentralization. Hybrid or consortium blockchains could also cater for entities that share business activities. Shared governance structures and control mechanisms then need to be implemented, and therefore reliance might need to be placed on the controls of other stakeholders, which might complicate the task of auditors.

The literature also refers to triple-entry accounting created by blockchains. The third-party capturing of the transactions by banks, for instance, is effectively replaced by the verification and capturing of the transaction in the blockchain system. However, no indication exists that the preparation of financial statements based on the double-entry system will change. Through data analysis and related machine learning techniques, the way that accounting information is analysed and presented might change.

The secured audit trail and verification created by a blockchain system and real-time capturing of transactions creates the possibility of continuous auditing by both internal and external auditors. The literature identifies that continuous auditing might start firstly with internal auditing, which is closer to new developments in the entity. The external auditor might need to be involved in the development of the blockchain system to secure the availability of the required information, which might compromise the independence of the external auditor. Obtaining real-time information creates the opportunity for earlier interventions, if needed, and could be less disruptive for the staff of the audit client. Continuous auditing is still subjected to testing and relying on the internal control systems and related information technology controls and whether all the needed information is available in real-time. Audit scepticism and review of management assumptions and estimates will still be needed. Continuous auditing might be difficult to achieve if the accounting system is still separate from the blockchain system.

Smart contracts will also have a significant impact on both accountants and auditors. Through smart contracts, accounting control and verification procedures could be implemented, and the question is whether financial reporting standards requirements could be implemented through smart contracts. Smart contracts could also be used to obtain and

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analyse audit data from the system. The accountant and auditor of the future will need to understand the application of smart contracts.

Finally, blockchain developments should not be seen independently of other technological developments. The accountant and auditor of the future needs to understand how data analytics and related machine learning techniques could be used to analyse and interpret data, how storing of information in the cloud or other blockchain systems could enhance their functions and how other technological developments could assist them. The real-time ability of blockchain makes the integration of such technologies more possible.

This article is limited to the interpretation of literature by the authors. Further, research could assess how blockchains are being used in practice for accounting and auditing purposes and whether integrated accounting and auditing systems can be developed on blockchain systems.

REFERENCES

Allen, D.W., Berg, A., & MarkeyTowler, B. (2018). Blockchain and supply chains: V-form organisations, value redistributions, de-commoditisation and quality proxies.

Allen, D.W., Berg, A., & MarkeyTowler, B. (2019). Blockchain and Supply Chains: V-form Organisations, Value Redistributions, De-commoditisation and Quality Proxies', *The Journal of the British Blockchain Association, 2*(1), 57-65.

Allison, I. (2015). Bank of England: Central banks looking at'hybrid systems' using Bitcoin's blockchain technology. *International Business Time. July*, *16*.

Cholvi, V., Anta, A.F., Georgiou, C., Nicolaou, N., & Raynal, M. (2020). Atomic Appends in Asynchronous Byzantine Distributed Ledgers. In *2020 16th European Dependable Computing Conference (EDCC)* (pp. 77-84). *IEEE*.

Atzori, L., Iera, A., & Morabito, G. (2010). The internet of things: A survey. *Computer Networks*, *54*(15), 2787-2805.

Babbitt, D., & Dietz, J. (2014). Crypto-economic design: a proposed agent-based modeling effort. In *English. Conference Talk. University of Notre Dame, Notre Dame, USA*.

Back, A., Corallo, M., Dashjr, L., Friedenbach, M., Maxwell, G., Miller, A., ... & Wuille, P. (2014). Enabling blockchain innovations with pegged sidechains. *URL: http://www. opensciencereview. com/papers/123/enablingblockchain-innovations-with-pegged-sidechains*, *72*.

Böhme, R., Christin, N., Edelman, B., & Moore, T. (2015). Bitcoin: Economics, technology, and governance. *Journal of economic Perspectives*, *29*(2), 213-38.

Brown, R.G. (2014). The Unbundling of trust: How to identify good cryptocurrency opportunities. *Retrieved January*, *18*, 2019.

Solankar, A. (2021). Secure E-Voting System Using Visual Cryptography & Block Chain Ledger. *Turkish Journal of Computer and Mathematics Education (TURCOMAT)*, *12*(1S), 7-12.

Carter, D., & Rogers, I. (2014). Fifteen years of 'Utopia': Napster and Pitchfork as technologies of democratization. *First Monday*.

Chaum, D. (1983). Blind signatures for untraceable payments. In *Advances in cryptology* (pp. 199-203). Springer, Boston, MA.

Christensen, C.M. (2013). *The innovator's dilemma: when new technologies cause great firms to fail*. Harvard Business Review Press.

Coletti, P. (2015). Bitcoin's baby: Blockchain's' tamper-proof'revolution. *BBC News*, *20*.

Cong, Y., Du, H., & Vasarhelyi, M.A. (2018). Technological disruption in accounting and auditing.

Coyne, J.G., & McMickle, P.L. (2017). Can blockchains serve an accounting purpose?. *Journal of Emerging Technologies in Accounting*, *14*(2), 101-111.

Dai, J., & Vasarhelyi, M. A. (2017). Toward blockchain-based accounting and assurance. *Journal of Information Systems*, *31*(3), 5-21.

Derose, C. (2015). Blockchain for Beginners-Behind the Ingenious Security Feature that Powers the Blockchain. *American Banker*, *21*.

Dwyer, G.P. (2015). The economics of Bitcoin and similar private digital currencies. *Journal of financial stability*, *17*, 81-91.

Evans, D.S. (2014). Economic aspects of Bitcoin and other decentralized public-ledger currency platforms. *University of Chicago Coase-Sandor Institute for Law & Economics Research Paper*, (685).

Gomaa, A.A., Gomaa, M.I., & Stampone, A. (2019). A transaction on the blockchain: An AIS perspective, intro case to explain transactions on the ERP and the role of the internal and external auditor. *Journal of*

Citation Information: Adelowotan, M., & Coetsee, D. (2021). Blockchain technology and implications for accounting practice. *Academy of Accounting and Financial Studies Journal, 25*(7), 1-14.

Emerging Technologies in Accounting, *16*(1), 47-64.
Kinory, E., Smith, S.S., & Church, K.S. (2020). Exploring the playground: Blockchain prototype use cases with hyperledger composer. *Journal of Emerging Technologies in Accounting*, *17*(1), 77-88.
Kinory, E., Smith, S.S., & Church, K.S. (2020). Exploring the playground: Blockchain prototype use cases with hyperledger composer. *Journal of Emerging Technologies in Accounting*, *17*(1), 77-88.
Kinory, E., Smith, S.S., & Church, K.S. (2020). Exploring the playground: Blockchain prototype use cases with hyperledger composer. *Journal of Emerging Technologies in Accounting*, *17*(1), 77-88.
Richard, G., & Odendaal, E. (2020). Integrated reporting assurance practices—a study of South African firms. *International Journal of Disclosure and Governance*, *17*(4), 245-266.
Morhaim, L. (2019). *Blockchain and cryptocurrencies technologies and network structures: applications, implications and beyond*. Infinite Study.
Nakamoto, S. (2008). Bitcoin: A peer-to-peer electronic cash system. *Decentralized Business Review*, 21260.
Rossi, S. (2004). *Central bank money and payment finality*. Centro di studi bancari Villa Negroni-RME LAB Research Laboratory of Monetary Economics.
Arner, D.W., & Barberis, J. (2015). FinTech in China: from the shadows?. *Journal of Financial Perspectives*, *3*(3), 78-91.
Pilkington, M. (2015). "Blockchain Technology: Principles and Applications" Available at: https://www.semanticscholar.org/paper/Blockchain-Technology%3A-Principles-and-Applications-
Polyviou, A., Velanas, P., & Soldatos, J. (2019). Blockchain technology: financial sector applications beyond cryptocurrencies. In *Multidisciplinary Digital Publishing Institute Proceedings*, *28*(1), 7.
Qasim, A., & Kharbat, F.F. (2020). Blockchain technology, business data analytics, and artificial intelligence: Use in the accounting profession and ideas for inclusion into the accounting curriculum. *Journal of Emerging Technologies in Accounting*, *17*(1), 107-117.
Raikwar, M., Gligoroski, D., & Kralevska, K. (2019). SoK of used cryptography in blockchain. *IEEE Access*, *7*, 148550-148575.
Rozario, A.M., & Thomas, C. (2019). Reengineering the audit with blockchain and smart contracts. *Journal of Emerging Technologies in Accounting*, *16*(1), 21-35.
Saper, N. (2012). International cryptography regulation and the global information economy. *Nw. J. Tech. & Intell. Prop.*, *11*, xv.
Sheldon, M.D. (2019). A primer for information technology general control considerations on a private and permissioned blockchain audit. *Current Issues in Auditing*, *13*(1), A15-A29.
Smith, S.S., & Castonguay, J.J. (2020). Blockchain and accounting governance: Emerging issues and considerations for accounting and assurance professionals. *Journal of Emerging Technologies in Accounting*, *17*(1), 119-131.
Smith, S.S., Petkov, R., & Lahijani, R. (2019). Blockchain and Cryptocurrencies-Considerations for Treatment and Reporting for Financial Services Professionals. *International Journal of Digital Accounting Research*, *19*.
Srinivisan, B.S. (2015). A bitcoin miner in every device and in every hand. *Medium blog post*, *May*, *18*.
Wang, L., Shen, X., Li, J., Shao, J., & Yang, Y. (2019). Cryptographic primitives in blockchains. *Journal of Network and Computer Applications*, *127*, 43-58.
Watson, L.A., & Mishler, C. (2017). Get ready for blockchain: should management accountants add blockchain technology to their professional vocabulary?. *Strategic Finance*, *98*(7), 62-64.
Yu, T., Lin, Z., & Tang, Q. (2018). Blockchain: the introduction and its application in financial accounting. *Journal of Corporate Accounting & Finance*, *29*(4), 37-47.
Zheng, Z., Xie, S., Dai, H.N., Chen, X., & Wang, H. (2018). Blockchain challenges and opportunities: A survey. *International Journal of Web and Grid Services*, *14*(4), 352-375.

Citation Information: Adelowotan, M., & Coetsee, D. (2021). Blockchain technology and implications for accounting practice. *Academy of Accounting and Financial Studies Journal, 25*(7), 1-14.