Blockchain and its implications for accounting and auditing

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Abstract

Purpose – Technological developments such as blockchain seem to be the next step in a digital era and might reshape the way we do business. They are expected to have an impact on both business and society in the next few decades. This paper aims to provide general insights into blockchain technology and the extent to which it might transform the accounting system.

Design/methodology/approach – Analysing the previous literature, the paper provides a general overview of this phenomenon, identifying pending technical as well as non-technical issues that will have to be addressed for the full potential of blockchain technology to be embraced. The paper also proposes ways in which the information quality dimension might be improved.

Findings – The paper identifies the pending challenges for blockchain, such as scalability, flexibility, a suitable architecture and cybersecurity. Additionally, to integrate blockchain technology fully into a real accounting ecosystem, a consensus between regulators, auditors and other parties is needed.

Originality/value – A general overview of this new phenomenon, as well as a summary of how the quality of accounting information might be improved, is provided. Given that it features elements such as decentralization and transparency, blockchain certainly has the potential to improve information and accounting quality.

Keywords Accounting, Auditing, Blockchain, Information quality dimension, Distributed ledger technology

Paper type General review

1. Introduction and background

The internet, a complex global network, has changed our world and revolutionized the way we exchange information. However, it has proved to be less useful when it comes to exchanging values (Warburg, 2016). The unstoppable digital evolution led to the development of blockchain, a peer-to-peer (P2P)-based distributed network, which makes the exchange of value possible by registering and transferring it in a tamper-proof way. Indeed, blockchain seems to be the next step in the digital era, and it is expected to have an impact on business and society. Thus, it attracts the attention of both academics and practitioners.

Blockchain is a distributed digital ledger that is used to record and share information through a P2P network (Ducas and Wilner, 2017). Identical copies of the ledger are maintained and validated collectively by the members of the network, with approved transactions added in blocks that are added to a chronological chain of previously validated blocks, using a cryptographic signature (hash). Each new block is marked chronologically – a temporary coding process that corresponds to the creation of new and immutable data – and contains information that refers to the block that preceded it, ensuring that any attempt...
to alter the blockchain would require the alteration of each block previously created, something almost impossible given the decentralized nature of the technology (Buterin, 2014).

The main feature of blockchain is decentralization, which occurs because the records are stored at different nodes instead of at a single location; they are accessible to every authorized participant, and they are immutable. The final result is a highly efficient, transparent and secure method of performing transactions, and it serves as an online ledger that keeps a record of transactions and cannot be modified (Buterin, 2014).

Although blockchain initially gained recognition as the technology that underpins the cryptocurrency bitcoin, its ability to transform payment processing, invoicing, inventory information, contracts and other documentation has significant implications for accounting too (Dai and Vasarhelyi, 2017).

The Big Four accountancy firms have also expressed their interest in blockchain technology. As a result, several projects have been launched. Collaboration between major financial and professional institutions has led to various initiatives that aim to explore the potential of this technology for accounting and auditing. For example, Deloitte launched the first blockchain based software platform, called Rubix, which allows users to build a customized blockchain and smart contracts (Minichiello, 2015). Indeed, Deloitte’s clients can already use this platform for different applications such as automating financial reconciliations among internal departments or business partners, real-time assurance of financial statements and land registry or loyalty points programs. Additionally, the company is constantly working on automating some of its auditing processing for its clients. In 2017, Deloitte claimed that it had successfully performed a blockchain audit in which existing auditing standards were applied to examine a permissioned blockchain application (Das, 2017). KPMG has also seized the potential of blockchain, claiming that it allows faster and more secure transactions, automates back-office operations and reduces costs (KPMG, 2017). KPMG developed its digital ledger services in collaboration with Microsoft. Their current focus is on creating prototype models to address blockchain implementation challenges in the financial services industry, healthcare and the public sector (Kokina et al., 2017). Similarly, Ernst & Young is involved in another blockchain-based project, Libra, which is a start-up focused on distributed ledgers (Allison, 2015). In addition, it has developed EY Ops Chain, which focuses on payments, invoicing, inventory information, pricing, and digital contract integration (Prisco, 2017). PWC launched a report on blockchain related to energy concerns (PWC, 2017). It also created a platform called De Novo that focuses on the implementation of blockchain in the supply chain. We are witnessing an interesting shift in auditing, which is being transformed by technology, and the involvement of the Big Four in blockchain initiatives only demonstrates the importance of this idea to accounting and auditing. In 2016, the Big Four met with the AICPAs to create a consortium to examine blockchain solutions for accounting and auditing (Kokina et al., 2017). In 2017, the Accounting Blockchain Coalition Conference was held, which led to the creation of working groups to collaborate with the standard setters and assist in developing accounting standards to regulate blockchain use (Del Castillo, 2017).

A wide range of industries might leverage this distributed ledger technology. In 2016, banks and investment funds invested up to $1.4bn in blockchain technologies (Nyumbayire, 2017). However, investors investigating the potential of this new phenomenon and its implications are not limited to large technological companies and the financial sector. Other industries, as well as institutions such as central banks and public administrations, are not lagging behind in terms of research related to blockchain technology (BCT) applications. Indeed, numerous pilot programs have been launched under the supervision of the Dutch...
and UK governments (Ølnes, 2017). Thus, there is a common belief that blockchain will change the way we exchange and store values and information, and the following decade is expected to bring upheavals in different sectors because of this new technology.

Our motivation in conducting this study was the need for accounting academics and practitioners to gain more insights into this technology to make advances in digital accounting research and practice.

Our paper focuses on the implications of BCT for corporate accounting. Given that blockchain might represent an innovative approach in this area and might fundamentally change current accounting practices, it is worth exploring the potential and challenges of this technology in the accounting ecosystem, and analysing the extent to which this sphere might be transformed.

The aim of this study is twofold. First, as there is a limited research on this topic, a general overview and insights into the previous literature will be outlined and discussed. Secondly, this paper aims to analyse the transformation of the current accounting model by discussing the benefits, but also the challenges, of BCT adoption. Additionally, we try to identify the implications of BCT in the field of auditing.

The reminder of this paper is organized as follows. The second section offers insights into the literature review. The third section deals with the main benefits and challenges of blockchain for accounting, and its disruptive potential. The fourth part is dedicated to discussion and conclusions as well as identifying future areas for research.

2. History of blockchain, basic technical aspects and literature review

In 2008, Satoshi Nakamoto developed a peer-to-peer network, a shared data structure (blockchain) following a set of rules (Nakamoto, 2008). This was the technology underlying a digital currency, bitcoin. To avoid the failure that had faced the previous attempts of his peers (Nick Szabo and Wei Dai), Nakamoto had to find a way to make the network decentralized, hard to attack and with a real intrinsic value (Nyumbayire, 2017).

To make the whole system work he also had to solve challenges related to distrust, security and capacity. Distrust is quite realistic when it comes to value transactions among unknown participants, and therefore a simple peer-to-peer network would not have been sufficient. Hence, the Nakamoto consensus[1] was applied. This consists of a set of rules related to the validation of the transactions. Once validated, a transaction is added to a block. The transaction blocks are groups of transactions cryptographically connected into an unbreakable chain of blocks, or blockchain, which should guarantee the security of the data[2].

A key component of blockchain, the Merkle Tree, was created as early as 1979, and revolutionized the world of cryptography. A Merkle Tree, to put it simply, is a method of structuring data that allows for the quick and efficient verification of the accuracy of a large amount of information. Thus, Merkle Trees were used extensively in the foundational code for bitcoin. Through a mathematical process, Merkle Trees take a huge number of transaction IDs and transform them into a single 64-character code[3]. Hence, they allow a small amount of data to be used to process and verify transactions and, therefore, solve the memory space problem (Buterin, 2014). The potential of distributed database technology beyond bitcoin was soon realized, and new applications followed, together with the revival of certain applications with great potential that had been developed previously but had not been successful without the existence of a distributed ledger. An example of such a revival is the smart contract.

Smart contracts are contracts that self-execute. Buterin (2014) defines smart contracts as systems which automatically move digital assets according to arbitrary pre-specified rules.
Although the concept was first introduced by Szabo (1994), it did not thrive until the development of distributed database technology. Without this technology, a trusted third party was necessary to oversee and to execute the contract, while with blockchain the automated execution of smart contracts became feasible as the oversight responsibilities were distributed among the participating nodes (Dai and Vasarhelyi, 2017). Thus, with blockchain, smart contracts can be used more easily than with the technology available at the time of their invention (Nofer et al., 2017). A smart contract is based on a pre-defined business logic that is agreed upon by the contractual partners (Rozario and Vasarhelyi, 2018). Once the logic is set up, it can be programmed and stored on the blockchain ledger. Blockchain users activate the smart contract by sending data to it. Further, the smart contract verifies the received inputs against the pre-defined rules and releases an output. If the required conditions are not met, an error message is released to all participants. Similarly, the status of the smart contract is visible to all nodes in the network (Rozario and Vasarhelyi, 2018). Autonomous agents are groups of smart contracts that act like rich applications. They are expected to eliminate agency costs. There is also a vision that such agents might in the future lead to highly distributed companies with little or no need for management (Tapscott and Tapscott, 2016).

Despite the potential of this topic in the accounting and auditing field, the literature on it is rather scarce. A previous academic study worth mentioning is a brief discussion on how blockchain enables real-time accounting (Yermack, 2017). The benefits of BCT for the auditing profession have been outlined by Fanning and Centers (2016). Kiviat (2015) introduced the idea of “triple-entry accounting” using a decentralized network. Its application in banking ledger processing has been presented by Peters and Panay (2016). Kokina et al. (2017) outlined the implications of blockchain for accounting by explaining the basic concepts and history, and the initiatives carried out in this field. O’Leary (2017) provided insights into the implications of blockchain for the accounting and supply chain. Coyne and McMickle (2017), on the other hand, adopted a more critical approach towards this technology by outlining the main challenges of using blockchain in accounting. Although these studies shed some light on the concept of BCT in accounting or auditing and provide some insights into how the technology might be applied, detailed mechanisms and explicit illustrations of how to use it are still missing. More detailed illustration has been provided by Dai and Vasarhelyi (2017), who proposed the utilization of blockchain in a generic accounting system. Similarly, Rozario and Vasarhelyi (2018) outlined the usage of this technology in auditing.

3. Blockchain architecture, potential and challenges
3.1 Blockchain design and architecture
When designing blockchain architecture, four key design decisions have to be made; these are related to control, data ownership, privacy and access (Ølnes, 2017). However, the greater the control that is put in, the further the blockchain architecture is from its initial vision. The main BCT architecture attributes are public as opposed to private and permissioned as opposed to permissionless (Mainelli and Smith, 2015; Walport, 2015).

3.1.1 Private vs public architecture. The only difference between public and private blockchain is related to who is allowed to participate, to execute the consensus protocol and to maintain the shared ledger (Jayachandran, 2017). With public architecture, the transactions are publicly visible and each participant can generate a transaction for the other participants. A private blockchain, on the other hand, has a preselected number of nodes who are authorized to use the ledger. According to O’Leary (2017), public blockchain is not the most appropriate approach to capture accounting transactions, as competitors...
would have access to the entire set of transactions. Therefore, private blockchains are more likely to dominate corporate blockchain uses (O’Leary, 2017).

3.1.2 Permissioned vs permissionless. Permissioned (centralized), as opposed to permissionless (decentralized), features determine what accesses or views are granted. Typically, private blockchains are centralized, and public blockchains are decentralized (O’Leary, 2017). Nevertheless, certain combinations are possible (Table I).

While there are various options for blockchain architectures, a private blockchain seems to be the most suitable solution for enterprise applications. This is designed on the basis of a closed group of designated validators who verify and execute transactions. The security of the design is guaranteed, as the validators cannot tamper with the transaction or modify the ledger outside the pre-established rules.

As a blockchain can differ according to who can access the copies of the ledger and who maintains the ledger, the exact design of the blockchain ultimately affects the potential benefits it can offer.

### 3.2 General benefits and challenges of blockchain technology

In the following, the potential benefits and promises, as well as the pending challenges, of BCT are discussed. However, as the technology is still in its early stage, more empirical evidence is needed to confirm or reject these benefits and challenges.

#### 3.2.1 Reduction of economic uncertainty

North (1991), a pioneer of the new institutional economics and a Nobel Prize winner, explored the role of institutions in the performance of economics. He argued that institutions in economics are tools to lower our uncertainties. He saw institutions as the rule setters of the game, setting both formal legal rules such as constitutions and informal social norms that shape social interactions. Indeed, over the years as society has become more complex, the trust between trading parties has decreased because of complexity and distance. Thus, formal institutions such as banks and government corporations were created to facilitate the exchange of value and trade by lowering the uncertainties among the different participants. Recently, we have entered a new era in which uncertainty can be mitigated by technology alone (Warburg, 2016). The need for a tool that combats distrust and allows our economic wheels to function remains, but the tool is just replaced by technology. Blockchain as an “intermediary” means that whether or not the preconditions for a certain transaction are met can be certified and verified, at low (or no) cost. Thus blockchain reduces verification costs as a result of its

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### Table I. Blockchain architectures

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<td><strong>Private and permissioned (centralized)</strong></td>
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**Source:** Authors’ elaboration based on Ølnes (2017)
transparency and the use of cryptography. If there is misbehaviour or a failure, it can be seen who or what is responsible for this. When talking about transactions, we can be referring to any digital content, not just value transfer. The use of smart contracts, programmable contracts that can be executed and verified on the blockchain, is particularly efficient, and enabling the automation of the execution of transactions and reducing the associated costs and risks.

3.2.2 Reduction of agency costs and information asymmetry. Among the theories that might be applied to give meaning to the existence of blockchain is agency theory. One of the building blocks of this theory is the idea that there is information asymmetry between different agents. According to agency theory, increased transparency and accountability reduces information asymmetry between stakeholders and can therefore minimize potential agency problems (Gray et al., 1995; Abraham and Cox, 2007). Nyumbayire (2017) argues that blockchain allows the verification of whether a certain agent has executed a certain action in a certain time. The actions on the blockchain are traceable through the use of proofs of existence. In this way, the probability of an agent’s misbehaviour might be reduced or even eliminated. Because the blockchain enables the easy verification of any computable transaction, it reinforces the accountability of agents and helps to minimize agency costs. Indeed, it reduces the need for most of the intermediation currently required by the legal system, which is used to verify the preconditions, execution and post-conditions of economic and political transactions (Nyumbayire, 2017). The only remaining agency costs are those related to the transactions that require technical expertise or are partially off-chain. Thus, using the proofs of existence, smart contracts, and autonomous agents, blockchain technology allows users to execute and verify even complex contracts on a relatively low cost basis.

3.2.3 Increased transparency and auditability. Transactions are stored in multiple places, and every participant obtains a copy of the ledger; thus, all transactions are visible to every node in the architecture. This increases transparency and auditability (Atzori, 2015; Palfreyman, 2015; Tapscott and Tapscott, 2016; Underwood, 2016) and facilitates better access to information (Palfreyman, 2015; Swan, 2015).

3.2.4 Increased trust and reliability. Control is also increased via the consensus that is needed to add a transaction into a block (Mainelli and Smith, 2015; Zyskind and Nathan, 2015; Kraft, 2016). This consensus leads to increased trust and increased reliability of data, as transactions are verified by multiple nodes (Swan, 2015; Mainelli and Smith, 2015; Palfreyman, 2015; Zyskind and Nathan, 2015).

3.2.5 Reduction of costs, human error and fraud. Cai and Zhu (2016) point out that there is a reduction in human error because there are automatic transactions and controls. According to Palfreyman (2015) and Tapscott and Tapscott (2016), BCT can also reduce the costs of executing and validating a transaction through automated verifications. Some authors also claim that BCT might help to avoid fraud and manipulation (Swan, 2015; Cai and Zhu, 2016), and even to reduce corruption (Kshetri, 2017), because a data entry cannot be altered once it has been cryptographically sealed.

3.2.6 Improved data quality. Palfreyman (2015) and Tapscott and Tapscott (2016) also argue that BCT leads to data integrity and higher data quality. Table II outlines how different dimensions of information quality might be improved as a result of the blockchain features.

3.2.7 Solution to privacy paradox. Additionally, according to Tapscott and Tapscott (2016), this technology might solve a current problem with data privacy. With each piece of information we provide about ourselves, and with every move we make online, we create a virtual stamp, and this “virtual us” is not owned by us. BCT might solve this problem by
cryptographically organizing our identity into a “black box” that would enable us to share just the information necessary for a particular transaction. Palfreyman (2015) states that this phenomenon resolves the “privacy paradox”, claiming that blockchain is able to deliver effective identity management solutions while minimizing citizen privacy concerns around “who can see what”.

### 3.2.8 Supply chain transparency

Regarding the traceable asset history, blockchain offers more transparency in the supply chain and enables us to know the “story” of an asset. This becomes essential, as more socially responsible consumers want to know where and how their products are made, to avoid buying products that were not produced in compliance with fair trade standards or by certified suppliers. Additionally, the new EU Directive (Directive EU 2019/633, 2019) requires more disclosure on corporate supply chains. Hence, blockchain could enable the safe digital transfer of asset information across the supply chain, offering transparency to all nodes including the final user and the regulatory authorities (Palfreyman, 2015).

Although many authors point to the variety of benefits that BCT might bring, many of these benefits are not supported by empirical evidence. In what follows, general challenges of BCT are discussed.

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<th>Information quality dimensions (IFRS)</th>
<th>Improvement of information quality obtained with BCT</th>
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<tr>
<td>Completeness (IFRS)</td>
<td>Information has to be complete (the requirements of completeness are predefined by approved nodes) to be verified</td>
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<tr>
<td>Interpretability and clarity (IFRS)</td>
<td>As a result of the predefined requirements for completeness, the interpretability and clarity of information is increased. Each entry of the blockchain has predefined fields that have to be filled in. This facilitates the interpretation of information. This feature might even be improved as BCT becomes more mature and certain XBRL blockchain taxonomy is developed</td>
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<tr>
<td>Relevancy (IFRS)</td>
<td>Different access levels are possible. Some nodes, such as the CEO of the company, or the auditing company, might have access to all information, while other stakeholders might have limited access (only aggregated information is displayed) based on their predetermined roles. Some content might be available to users who have a decryption key. Hence, each node has the access to the information that is relevant to him</td>
</tr>
<tr>
<td>Comparability (IFRS)</td>
<td>As a result of certain standardization in predefined fields, information of a similar nature might be easily compared</td>
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According to Nyumbayire (2017), limitations on the number of transactions per second result in a lower scalability of the system. The fact that any future development needs to be supported by a majority of users leads to less flexibility. This problem is of greater importance in public decentralized architecture, and is more manageable in smaller private designs (Ølnes, 2017). Perhaps one of the most disturbing issues is security. A public decentralized blockchain faces a challenge: if a group of miners manages more than 50 per cent of the computational power, they can successfully attack the system by adding erroneous blocks (Atzei et al., 2017). Although Tapscott and Tapscott (2016) argue that the energy consumption of the network is reduced because of the increased efficiency of transaction mechanisms, Nyumbayire (2017) points to environmental sustainability as an issue, explaining that hard-mining algorithms require a high amount of electricity. Moreover, as the technology grows the algorithms become more complicated, more time and energy is required for the verification and validation of transactions. Another potential issue is the fungibility related to transparency, which might be a double-edged weapon as it might undermine the security of users.

3.3 Potential promises and challenges of blockchain technology in accounting

Deloitte (2016) highlights some of the main characteristics of this technology for specific uses and cases in accounting. Using BCT, companies can type entries (transactions) into a joint register. In this way they can create an interlocking system of enduring accounting records instead of keeping separate records based on transaction receipts. Every entry is distributed and cryptographically sealed and, therefore, falsifying or destroying it is practically impossible. As we can see, this technology offers, on the one hand, interesting opportunities in terms of avoiding the systematic duplication of efforts, eliminating human errors and the costs of periodical controls, and limiting fraud and misbehaviour but, on the other hand, it exposes the tricky and delicate issue of having enduring accounting registers that cannot be modified.

Dai and Vasarhelyi (2017) outline the main blockchain functions in an accounting ecosystem. These are the protection of data integrity, the instant sharing of necessary information, and the automatic control of processes.

3.3.1 Distributed consensual accounting records (DCAR). According to Bonsón and Bednárová (2018), blockchain enables the concept of distributed consensual accounting records (DCAR) to be introduced, which adds new dimensions to accounting and has implications for continuous accounting, auditing, and reporting. DCAR would imply that, once a transaction has been approved by the participants (nodes) of the block (e.g. the supplier, client, auditor, regulator, public administration), it is registered and cryptographically sealed, which guarantees the immutability of the data entry. Additionally, every record is stored in multiple places and every participant obtains a copy of the ledger. Nevertheless, none of the components embedded in this technology are necessarily innovative. Accounting information systems are able to develop applications that are decentralized or embed some automation. However, according to Smith (2018), connecting blockchain functionality to continuous accounting is possible through the combination of all elements (immutability, consensus, decentralization, and encryption). This would solve a critical flaw in the current financial reporting process, which, despite the integration of technology, is not able to provide data and information in a secure and continuous manner (Smith, 2018).

3.3.2 Triple-entry bookkeeping and blockchain. Triple-entry bookkeeping is a method proposed in the 1980s but popularized with the advance of BCT. Originally, it was an enhancement to the traditional double-entry system, with transaction processing authorization being required from an independent and reliable intermediary for each
accounting record (Grigg, 2005). This guarantees that the bookkeeping entries of both parties to a given transaction are congruent. With the development of blockchain, instead of two separate sets of accounting records and the need for an independent intermediary, the transactions are distributed, cryptographically sealed and linked (Kiviat, 2015). Hence, modifying them with a malicious intention (e.g. tax fraud) is practically impossible. Thus, blockchain creates an interlocking system of permanent accounting records, which has implications for continuous auditing. While triple-entry bookkeeping reduces the risk of fraud and errors by keeping a non-biased record, BCT adds some value to this concept by creating an immutable history of all the transactions within a system. Hence, it facilitates continuous accounting and auditing (Dai and Vasarhelyi, 2017).

To design the appropriate blockchain architecture for accounting purposes, a number of aspects have to be taken into account, such as node selection, database structure, authorization, verification protocols, etc. Figure 1 outlines a simplified version of a blockchain ecosystem with private permissioned architecture.

The specific features of this technology might give accounting and auditing new dimensions. BCT architecture gives a company the ability to share a ledger with other participants (nodes) such as suppliers, clients, banks, the public administration authorities or even its auditing company, and this is updated every time a transaction is executed through peer-to-peer replications (Figure 2). Cryptography is used to ensure that particular nodes can only see the parts of the ledger that are relevant to them, which solves the ‘privacy paradox’. Additionally, it ensures that transactions are secure, authenticated and verified (Palfreyman, 2015). Another valuable feature of BCT for accounting is that it allows the contract for an asset transfer to be embedded within the distributed database, and thus the

![Blockchain Ecosystem](image_url)

**Source:** Author’s elaboration
transactions are backed up with the relevant data and the asset history is traceable. When designing the architecture, the nodes in the network have to agree how transactions will be verified. This might be done through consensus or a similar mechanism such as smart contracts. Similarly, as the permissions have to be determined to designate ‘who can see what’ within a distributed ledger.

Internally, the design might allow the CEO and CFO of a company to have full access to all accounting data. Other internal stakeholders or company departments might have limited access – for example, warehouse operators would see the stock information and material entries. Additionally, there is a possibility that smart contracts could be integrated with internet of things (IoT) technologies (Dai and Vasarhelyi, 2017) to automate the bookkeeping processes. Similarly, the HR department would have access to tailored information about employees, smart contracts could be used to monitor the working hours or holidays of employees, and payslips might be generated automatically. External stakeholders such as investors would have access to aggregated information, with the possibility of the incorporation of big data, which would lead to better informed decisions. Similarly, the public administration might have access to certain data such as payable and receivable accounts, and tax filings could be automated. The auditing company, on the other hand, would have a full access to ensure that transactions were being registered in compliance with accounting standards.

Indeed, a suitable design of a company’s blockchain architecture might increase the efficiency of transactions among different stakeholders, with public administration oversight and auditing being part of the same network. A simplified version of a transaction within a blockchain is depicted in Figure 2.
Indeed, it seems that applying BCT to accounting might have positive implications, as it can improve the efficiency of money, asset and data transactions while tackling issues such as privacy and security. It might offer the following: better auditability; increased control, reliability and trust; reduced costs (e.g. of control, transactions, and duplications) and human error; better access to information (each node has a full copy of those transactions that are relevant to it); and the avoidance of manipulation and fraud by offering a trusted recordkeeping.

Nevertheless, Coyne and McMickle (2017) identify possible flaws that hinder the implementation of BCT as a financial reporting tool. According to these authors, the main hurdles are:

- confidentiality in public blockchains;
- the threat of manipulation of private blockchains; and
- the limited verification of transactions.

A public, permissionless blockchain allows any user to view it, and thus a confidentiality issue arises. Although this might be tackled by replacing the transactions in a blockchain with hashes to preserve transaction verification without revealing private data to the public (Andersen, 2016), a private, permissioned blockchain (as discussed above) might appeal more to a firm. Nevertheless, there arises a new problem related to the adoption of technology. Coyne and McMickle (2017) argue that even if all the members of a supply chain adopt BCT, different firms might adopt different types of BCT, and this would force a company to have multiple duplicate blockchain databases. This issue is more difficult to tackle. Indeed, a satisfactory solution would require a certain maturity of the technology. An industry-based blockchain XBRL taxonomy might appear in the future, which would bring some standardization.

The manipulation of a private blockchain can occur through a security breach that would place 100 per cent control of the system in hands of an unauthorized individual (Coyne and McMickle, 2017). Hence, the main challenge here is to maximize the cybersecurity of the designed architecture to minimize the threat of cyberattacks.

Coyne and McMickle’s last concern relates to the limited verification of transactions. They argue that BCT verification methods are not sufficient for transaction validity from an accounting perspective. They also argue that the smart contract feature of recording a transaction according to predetermined rules is not unique to blockchain, and might actually be seen as an extension to many database configurations, including Enterprise Resource Planning ERP systems.

Indeed, there are alternative technologies that would deliver similar outcomes to blockchain for accounting purposes, such as distributed databases or ERP systems. Peters and Panay (2016) and Dai and Vasarhelyi (2017) provide a comparison between blockchain and these alternative technologies, identifying the similarities, but also the flaws that can be solved by blockchain. One of the flaws of distributed databases is that conflicts occur when multiple modifications are made simultaneously by different computers. This does not occur in blockchain-based databases, as every new entry creates a new block (Peters and Panay, 2016). Regarding ERP systems, blockchain can be seen as a new type of database that can actually be used in conjunction with an ERP system. Dai and Vasarhelyi (2017) list the advantages of blockchain in comparison to traditional ERP systems, pointing to decentralization (which can help to prevent manipulation), the prevention of any unauthorized data changes, and a design that operates autonomously with little human intervention.
Nevertheless, Dai and Vasarhelyi (2017) introduce three different areas of challenges (technological, organizational, and environmental) that might hinder the adoption of this technology in accounting and auditing. The technological context refers to the technical complexity of blockchain solutions, which require financial and time resources; hence, a company might struggle to find business partners (and other entities) with whom to share a decentralized architecture. The organizational context refers to the willingness of managers to accept this innovative approach. Thus, the perceived benefits must exceed the potential costs. The environmental context refers to the essential role of regulators in the adoption of BCT within the accounting ecosystem.

Those challenges have to be taken into account when predicting possible future scenarios for BCT adoption. Some of them might be tackled by designing a suitable architecture (with scalability, flexibility, and security) while others, particularly those related to acceptance and regulation, are more complex.

4. Discussion and conclusions

With the creation of BCT, we might be entering a new generation of the internet. These developments might reshape the way we do business, and they are expected to have an impact on both business and society in the next few decades. Blockchain seems to be the next step in the digital era and, given that it might cause upheavals in almost every industry by offering smart solutions for data and value transactions, it is expected to affect different areas of business including accounting. Thus, it attracts attention from both academics and practitioners. In this paper we aimed to analyse the technological background and the potential implications of this emerging technology for accounting and auditing.

After analysing the characteristics of blockchain architecture, private blockchain architecture seems to be an interesting tool for accounting, as it might offer solutions for better auditability, automated control and reliability of data. It would also result in reduced costs and fewer human errors by automating transactions through smart contracts and, importantly, it would help to avoid manipulation and fraud as well as enabling the instant sharing of information and enhancing information integrity (Atzori, 2015; Mainelli and Smith, 2015; Palfreyman, 2015; Zyskind and Nathan, 2015; Cai and Zhu, 2016; Kraft, 2016; Tapscott and Tapscott, 2016; Underwood, 2016; Dai and Vasarhelyi, 2017). Additionally, from an overview of the projects and research that are being launched in this area by the Big Four companies, we might get the idea that the transformation from accounting and auditing as we know it today to distributed ledger databases is just a matter of time.

Nevertheless, the technology is still at an early stage. Programmers and designers have to face many challenges to lead it to its maturity. Issues such as suitable architecture designs, flexibility and cybersecurity have to be addressed (Coyne and McMickle, 2017; Dai and Vasarhelyi, 2017). More pilot programs and research are therefore needed not only to tackle technological issues but also to shed more light on the potential of this new technology and its use in accounting. Last but not least, to integrate blockchain technology fully into a real ecosystem, non-technical issues such as reaching a consensus among regulators, auditors and public administrators would be inevitable.

As Alarcon and Ng (2018) point out, blockchain tends to generate two conflicting points of view: enthusiasm and scepticism. Thus, the large-scale adoption of this technology could depend on how quickly the concerns raised by the sceptics are addressed by the promoters. The blockchain enthusiasts believe that it will become a new infrastructure to manage value exchanges in the future, just as the internet provided the infrastructure to manage information exchanges. They argue that it will profoundly change the way in which the transactions are processed, recorded and analysed (Bonsón and Bednárová, 2018). For
sceptics, the technology seems to be too good to be true, and they claim that it is not currently reliable for users or regulators. They warn that the technology lacks maturity, scalability and standards. In addition, they point to a significant risk if credentials are compromised or stolen, and they raise concerns that it may be vulnerable to programming errors or system weaknesses because there is a lack of tools to ensure that the system works as intended (Coyne and McMickle, 2017). The reality is that technology seems to be advancing rapidly, and new consortia have emerged to accelerate the definition of industrial standards and to foster collaboration (Kokina et al., 2017). New approaches to security and privacy controls are also emerging.

Despite the pending challenges, the transformative potential of blockchain in accounting and auditing can be acknowledged, particularly in relation to continuous accounting, auditing, and reporting. Through blockchain-enabled concepts such as distributed consensual accounting records (DCAR), smart audit procedures, and blockchain-based triple-entry bookkeeping, continuous accounting and auditing have gained new dimensions and appear to be moving increasingly towards being realized (Rozario and Vasarhelyi, 2018; Wang and Kogan, 2018). The added value of blockchain, in comparison to other alternatives such as ERP or distributed databases, stems from the combination of all its elements, including immutability, consensus, decentralization, and encryption (Smith, 2018).

4.1 Implications for research and practice, and future research

This paper is among the first few studies on blockchain and its use in the accounting and auditing sphere. The main aim of this paper is to provide more insights into this emerging technology and its implications for the accounting ecosystem, and to describe advances in digital accounting research and practice. It offers an overview of the main features of blockchain, discusses its possible integration into accounting and auditing, outlines the main benefits and challenges, and analyses how different dimensions of information quality might be improved by applying this technology. Nevertheless, the paper has certain limitations. Given that blockchain is an under-explored phenomenon, future research is necessary to obtain a full understanding of this emerging technology and its implications for the accounting and auditing sphere. It will be important to monitor the progress of the implementation of blockchain in organizations, through case studies, and to explore the efficiencies achieved through its use. Similarly, an interesting approach for a future study might be to analyse how the ability to record transactions in real-time affects the accounting and auditing processes and how it alters the nature of accountants’ and auditors’ jobs. An interesting field of study might also be to analyse stakeholders’ awareness of this technology and to conduct some sort of acceptance analysis.

Notes

1. Not all blockchains follow this model.

2. Nevertheless, if 51 per cent of the network had malicious intentions and worked together, they could alter the blockchain. This would be extremely difficult.

3. This is the length of the transaction ID in most blockchains.

4. In Spanish, this is RC3 (registro contable consensuado compartido).

5. The cryptocurrency bitcoin is built upon this schema.
References


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