The Blockchain Technology and its Limitations for True Disruptiveness of Accounting and Assurance

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Abstract:

Blockchain is distributed ledger technology praised by many tech-savvy executives to disrupt and change many businesses in the future, including the accounting and assurance profession. This study critically assesses the disruptive potential of the technology for modern accounting information systems and accounting professionals. It summarizes limitations and constraints of the technology through qualitative research of academic literature, professional documents and tech websites. The study discusses scalability, transaction costs, interoperability and confidentiality issues as most significant constraints for accelerated adoption and deployment of blockchain based accounting information systems. The economic case of blockchain based accounting information system, real cases of practical implementation and appropriate governance structures are suggested as important areas for future research efforts.

Keywords: blockchain; accounting; smart contract; distributed ledger; disruptive technology.

JEL Classification: M15; M41; O33.

Introduction

The blockchain has recently received much global attention and credit by the tech industry and business leaders as one of starred industrial revolution 4.0 technologies. It has been regarded as one of the most disruptive technologies since the internet (Yermack 2017) or even "a game changer" (Andersen 2016). The technology owes its initial popularity to the bitcoin crypto currency, a medium of exchange that uses a peer-to-peer network for executing cross-border payments between members without the need of central authority for trust. The blockchain represents a distributed ledger that exists in multiple copies among each node (participant in the blockchain) and allows for transparent sequential recording of transactions once the consensus protocol is confirmed by each node. The recorded transactions are virtually immutable due to enormous computer processing power needed in order to change all copies of the ledger at each node. This is the main feature of the technology that makes it highly compelling for many organizations as well as regulators and government authorities.

The technology could find application in processes of storage, transmission and exchange, security and data processing. It is considered that through automation and lower cost of transacting the technology will transform many industries including cross-border payments in financial industry, insurance, global supply chain logistics, healthcare and energy (Grewal-Carr and Marshall 2016). In a global survey of more than 1000 blockchain savvy executives in 2018, Deloitte (2018) concluded that there is a shift in the momentum from learning and exploring focus to identifying and building practical business applications. The financial services sector is leading the way in

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developing uses for the blockchain, while the other sectors and industries remain more reserved and still explore the technology. The blockchain technology has potential to help government and regulatory authorities to collect taxes, issue passports, organize land registry records, set up clearing systems, track and increase transparency for budget execution. As an example, Australia Securities Exchange adopted the blockchain technology and plans to start using it to record shareholding and manage the clearing and settlement of equity transactions by 2021 (ASX 2018). United Arab Emirates have developed a visionary strategy to have 50% of government transactions on blockchain by 2021 (Deloitte 2018).

The technology has received full attention from the Big-4 and other global accounting firms who invest on their own and participate in consortia that explore the technology and prepare for blockchain advisory and assurance services for the future. Deloitte started working with blockchain in 2014 and offered its "one-stop blockchain software platform" known as Rubix (Andersen 2016). The Rubix global team employs more than 800 in 20 countries and aims to provide enterprise grade blockchain solutions to organizations and governments. They have developed more than 30 blockchain prototypes covering pharmaceutical supply chain, digital identity, cross-border payments, trade finance, property registries, loyalty and reward programs etc. Deloitte leads Big Four accounting firms into blockchain development activities and in 2017 first announced successful completion of blockchain audit. KPMG another Big Four firm, joined Microsoft in providing advisory services to clients for strategic adoption of the blockchain technology in financial industry, health care and government. In December 2019 it successfully launched a separate product, blockchain based solution called KPMG origins that offers clients transparency and traceability across the supply chain (KPMG 2019). In 2017, EY launched EY Ops Chain and started offering a blockchain solution for business processes in the health care, financial services and asset management, supply chain and procurement, as well as government spending and improved transparency in public finances. Obviously, Big Four accounting firms are not focusing solely on accounting and assurance implications and are seeking to explore the use of the technology and provide advisory services across different areas in business, finance, insurance, energy and public government.

Many share the view that blockchain will also disrupt the accounting profession and will implicate the design of accounting information systems, preventing financial statements fraud, increase cost efficiency, timeliness and coverage of auditing and assurance (Kokina *et al.* 2017, Dai and Vasarhelyi 2017, CPA and AICPA 2017). However, there are some challenges that need to be addressed in order to achieve appropriate maturity and use of the technology for the benefit of the accounting profession. These challenges relate to the scalability (Aranda 2017, O'Leary 2017, Kokina *et al* 2017), transaction processing costs and efficiency (Coyne and McMickle 2017, 108), interoperability when many different solutions are being developed and used and the business confidentiality or privacy issue (Wang and Kogan 2018, 6).

This study aims to investigate the blockchain technology and its implications for the accounting and assurance profession through review of academic research papers, project reports and websites that deal with the application of the technology in the accounting sphere. As a result of the investigation, the study provides and overview of the main features of the technology and how these could impact and change the accounting and assurance profession. Further more, by synthesizing relevant academic and professional views on current limitations of the technology, the study challenges the potential for its true disruptiveness for the profession in the near future.

The remainder of this paper proceeds as follows: the next section provides background information on the technology, section 3 discusses the possible implications of the blockchain for accounting and assurance, section 4 provides overview of major limitations and constraints for more accelerated adoption of the technology and last section concludes the paper with discussion on future research paths.

1. What is a Blockchain?

A blockchain can best be described as peer-to peer distributed digital ledger designed to record all transactions since its creation, in sequential continued archive. The distributed nature of the ledger means that there is no single authority or entity that has the power to control the transaction processing process. The concept was first introduced by Haber and Stornetta (1991) who proposed this idea in order to time-stamp the creation of intellectual digital property in order to safeguard property rights for the creator before the document has a chance to be copied further. The concept gained new momentum and world-wide popularity through Nakamoto's (2008) bitcoin proposal for peer-to-peer electronic cash system that disinter mediates global financial transactions. The bitcoins underlining blockchain records transactions with the currency in up to 10mb blocks, each connected through hash function.

As explained by Nakamoto (2008) each time the network runs, new transactions are initiated and broadcasted to all nodes in the network, where each node collects the transactions into a block. The "Nonce" or a

random number is used in the block and is related to the proof-of-work algorithm. It has such property that, when added to the other information in the block it generates a hash with certain number of leading zeros. Once successful node finds the hash it is verified by other nodes in the network. The costly computational process to find the hash and get awarded with new bitcoin, the so called proof-of–work process is what preserves hackers to update the blockchain with fraudulent data. The attempt to forge the information in blocks retroactively by changing a prior entry will cause change in the sequence in all subsequent blocks, which is impossible to be performed without observance by other nodes in the network that employ considerable processing power to mine subsequent blocks. Therefore, the described structure of the bitcoin blockchain has characteristics of decentralization, strong authentication and tamper resistance (Dai and Vasarhelyi 2017, CPA Canada and AICPA 2017, Yermack 2017). One of blockchain unique characteristics is the feature that full copies of the ledger are maintained on each active node in the network. So if one node goes offline, the ledger is readily available to all other participants, therefore it is save proof from a single point of failure.

The bitcoin blockchain is a permission less or public blockchain, but the technology could be employed for recording transactions privately within organizations. The distinction is made through the defined permissions who is allowed to participate in the network and can read and verify blocks, or execute the consensus protocol and maintain the ledger. Public blockchains permit public visibility of transactions in the block (although the key details encrypted) with no restrictions for anyone to see, initiate or participate in consensus process to verify the integrity of transactions. This decentralized consensus system provides the benefits of genuine trust from the public that derives from the technology instead of relying on the work of central authority. However, there are drawbacks if public blockchains are used in business setting. Disclosing even encrypted transactions may provide competitors the potential for business intelligence (O'Leary 2017, 143, Dai and Vasarhelyi 2017, 12, Wang and Kogan 2018). The complete history of transactions remains public, and while it is quite difficult to identify transaction parties from encrypted data, a possible side identification of a party will disclose it's complete transaction history (CPA Canada and AICPA 2017). In a private blockchain the participants are limited and preselected, either from a single organization or consortia of organizations that are provided with access to read and verify structured set of information.

Since the bitcoin appearance, the blockchain technology has evolved in several phases, marked by the community as blockchain 1.0, 2.0, 3.0 and 4.0. The first phase of the blockchain relates to crypto currency and potential disruption for financial systems through changes in money transfer and international payment system. The distinguishing feature of crypto currencies is their decentralized control by the mean of a public blockchain (Barnes 2019). Blockchain 2.0 are smart contracts which represent small autonomous computer programs on the blockchain that execute automatically when terms defined in a contract are met. The advantage of coding contracts as programs on the blockchain is the perfect execution without tampering. The purpose is to reduce costs of execution, verification of contract fulfillment, arbitration and fraud prevention (Dai and Vasarhelyi 2017, 9, Kiviat 2015, Peters and Panayi 2016).

Ethereum Blockchain is most popular example of this phase of the development of the technology. Smart contracts allow for expanding of trading from currency to other assets (securities, digital assets and other intangibles) and tokenization of physical assets. A token is a digital represent of an underlying object, which can be used to register detailed information on the asset, including ownership and to ease the transfer of ownership through new transaction records through the blockchain distributed ledger. Tokens provide opportunity to fractionalize ownership of certain rare property such as art, financial instruments, share of profit which allows creating and exchanging value confidently in new ways (Vaidyanathan 2017).

Blockchain 3.0 is expanding the blockchain systems from financial and business application toward Dapps (decentralized application), apps that are stored on decentralized network with no single point of failure. The difference between traditional and Dapps is that traditional apps backend code is running on centralized servers controlled by certain organization. Blockchain 4.0 means blockchain usable in industry where every machine, sensor or miscellaneous device are connected and has its own IP address similarly to every computer that has its own IP address at the start of the internet (Mezni 2018). Machines interact, report and operate on standby mode and they can evaluate their own performance, order important production parts or their replacement. The blockchain will represent the platform for the communication and dialogue between autonomous operating machines within and across organizations.

2. Possible Implications of the Blockchain for Accounting and Assurance

Many technological and IT innovations in the past 40 years have found genuine implementation in accounting and contributed to more efficient and secure processing of transactions and reporting of accounting information.

Nevertheless, the accounting worldwide is still based on traditional double-entry bookkeeping approach. The financial statements which are result of double-entry system need an independent third party (auditors) to test accounting records and provide credibility to financial reporting. The blockchain technology could fundamentally change accounting through practical evolution and improvement of what is known as triple-entry accounting mechanism (Grigg 2005). It's a system were neutral intermediary authorizes each two party transaction and creates additional entry record. The blockchain could replace the intermediary through improved mechanism of consensus protocol, run by multiple parties on the distributed ledger. This provides transparent authentication of transactions and prevents tampering of entries (Dai and Vasarhelyi 2017, O`Leary 2017, Schmitz and Leoni 2019).

Currently, most large companies use ERP solutions that allow for automation of transaction recording and provision of timely and accurate data for decision making. ERP systems are organized as centralized architecture, unlike blockchain where the power of transaction verification and storage is distributed. The distribution of verification power significantly reduces the risk of single point of failure (Peters and Panayi 2016). ERP accounting systems incorporate internal control procedures that mitigate the risk of tampering accounting entries retroactively. Still, in such traditional ledger environment, more or less, the management can manipulate accounting information through posting additional backdated entries. In an ERP environment there is no strict requirement in the architecture to publicly verify the genuine nature of the transaction. However, the adoption of the blockchain could prevent data tampering by replacing traditional ledger with public of permission ed ledger where multiple parties will verify transactions before they are recorded. According to Dai and Vasarhelyi (2017) blockchain can be considered as new type of database that can play the role of an accounting module inside the ERP system or can be used separately in conjunction with the existing accounting module in the system.

Smart contracts can be exploited on accounting blockchain to further increase the efficiency of the accounting process and comply with financial reporting requirements. A smart contract can be used for encoding accounting rules derived from accounting standards. It will allow for autonomous recording of transactions when certain criteria are meet by the underlining transactions (Dai and Vasarhelyi 2017, CPA and AICPA 2017, Yermack 2017, O'Leary 2018, Schmitz and Leoni 2019). For example, when the net realizable value of an inventory item falls below the cost, then a smart contract with encoded accounting rule will record autonomously adjustment of the cost value of the item. Dai and Vasarhelyi (2017) describe the accounting ecosystem on a blockchain, where smart contracts play important role. Internal controls can be implemented through smart contracts that will monitor accounting processes and perfectly execute corrective actions based on predetermined rules. They can be used for automatic processing and recording of payments of invoices, monitoring of completion of employees' assignment and paying dynamic salaries. Smart contracts can be combined with IoT (internet of things) technologies that will capture conditions and activities of physical objects. When the object, *i.e.,* item of inventory leaves the warehouse the IoT sensor sends information that executes smart contract that will post a record of sales in the blockchain ledger.

Related party transactions and compliance with arm's length principle is another area where the technology can provide benefits for tax authorities or other stakeholders such as creditors and minority shareholders. According to Yermack (2017, 18) real-time accounting on a public blockchain could provide pressure for the management and limit their ability to tunnel transactions and profits out of the firms due to increased ability of the public observers to spot suspicious transfers of assets. Companies will have greater costs to explain in more debt the nature of their transactions, compared to the current compliance approach considering related party transactions, where the disclosure rules place more choices for the management to decide whether it will self-report the related party transactions.

The blockchain could bring considerable challenges, but also opportunities for the audit and assurance profession. The auditors' approach in today's engagements is evolving towards automation and data analytics. If the blockchain technology is implemented in conjunction, it could initiate considerable changes in the way assurance procedures are designed and executed by accounting professionals. For the audit, the immutable records of the blockchain mean a comprehensive audit trail prone to corruptive actions of malicious actors. It is much harder in blockchain-based accounting system for any user to alter earlier transaction data. According to Vaidyanathan (2017) this can result in cost reductions for the audit and may reduce costs related to fraud detection. Moreover, auditors have traditionally relied on sampling while performing audit of financial statements, due to costs of reviewing all transactions and the need to complete an efficient audit. Recording all company transactions on distributed ledger could allow auditors to test all transactions through review of exception reports.

In respect of the timing of an audit engagement, traditionally it is more of an annual exercise. After the year end for the majority of the work needed, auditors receive reports, accounting records and other documents. They start prepare and reconcile data, perform analysis, plan and consecutively perform audit procedures to gain

sufficient appropriate evidence. Moreover, when auditors need to plan an audit engagement with different clients, there is a considerable audit time spent in understanding the unique setting of arrangements around data gathering, recording and reporting performed. Each time auditors are provided with different types of accounts reconciliations, adjustments journal entries, supporting spreadsheets and other files in different electronic and manual formats. These settings contribute for much labor intensive and time consuming preparation activities both for the client and the auditor. However, when the transactions have been recorded on a blockchain, the auditors don't need to spend much time in obtaining and reconciling data. The use of blockchain for transaction validation could result in continuous or nearly real-time audit throughout the year, immediately after transactions are arranged and recorded (PWC 2017, Vaidyanathan 2017, Schmitz and Leoni 2019, 337).

For certain, confirmation procedures used by auditors to confirm receivables, payables and other transaction balances and details will be eliminated upon adoption of the blockchain technology. In addition, the quality of evidence the auditors obtained in an audit will increase, since all documents on transactions recorded on the blockchain will be verified by third party. The real-time monitoring of transactions provided by the technology can help auditors better understand the nature of the business, transaction trends and promptly identify business and financial risks.

If more companies decide to transit to the blockchain technology, and presumably it does not evolve in many different variances, there is a potential for increase in the efficiency and effectiveness of financial reporting and auditing (CPA Canada and AICPA 2017, Kokina *et al.* 2017, 94, Vaidyanathan 2017). The increased efficiency and effectiveness will be a simple result of decreased lag time between the recording of transaction and assurance provided on the resulting information. The auditors could deploy smart contracts, extensive audit analytics and machine learning capabilities, for automation of transaction reconciliation procedures that will save time and reduce the risk of human errors in the assurance process (Kokina *et al.* 2017, Schmitz and Leoni 2019). However, it is highly unlikely that every transaction can be verified and reconciled through smart contracts. There will be a strong requirement for auditor's professional judgment to analyze complex accounting estimates and other judgments exercised by the management. These often incorporate fair value and other valuations or impairment testing and recognition of impairment allowance. Such estimates are company specific and not necessarily subject to verification by a third party.

It is questionable whether smart contracts can replace control procedures put in place to mitigate different cases of asset misappropriations. In terms of gathering sufficient and appropriate evidence on existence of transactions recorded on reliable blockchain, auditor as third party will need to be engaged to verify the origination of the transaction (Coyne and McMickle 2017, Dai and Vasarhelyi 2017, Schmitz and Leoni 2019). The auditors will need to attest the consistency of the recorded information on the blockchain with the physical world. Simple recording of transaction on the blockchain and successful verification through consensus protocol does not mean that the transaction happened in the real world. It can still be linked to side agreement between the parties, executed between concealed related parties or simply fraudulent or illegal. For the auditors, when auditing organization that has implemented the technology, it becomes increasingly important to focus on internal controls surrounding the blockchain, including client's incentives, the code quality, protocol changes and allocated powers among peers.

Some researchers have expressed more radical views, considering the impact of the blockchain technology significant to make accountants and auditors redundant or unnecessary for the future (Ovenden 2017, Patil 2017, Yermack 2017). The firm's transaction and accounting data could be recorded on a public or permissioned blockchain, allowing all interested parties to aggregate accounting data on income statements and balance sheets at any time. Apparently, there is no need to rely on the integrity of the management in preparation of financial statements and auditors' efforts and judgments to add credibility.

3. Limitations of the Blockchain

It is unquestionable that the blockchain has received the attention by many industries, businesses, governments and regulators recognizing the potential of the technology. There is also a growing hype around the technology among tech savvy business leaders. However, many of the anticipated benefits of the technology are a long way of becoming reality soon, as the very nature of the technology still imposes critical limitations (Aranda 2017). Researchers commonly emphasize the throughput time for transactions (scalability), processing power and transaction costs, interoperability, confidentiality and security of the blockchain (Aranda 2017, Coyne and McMickle 2017, Kokina *et al.* 2017, 94).

3.1. Scalability of the technology

By design the blockchain is a decentralized network of computers that uses the consensus mechanism for verifying transactions, where the verification process is computationally intensive. For example, Bitcoin on averages handles around 4 transactions per second with a throughput up to 7 tps (as per https://www.blockchain.com). Such capacity for processing transactions is incomparable to processing requirements of financial institutions, whose settlement networks and systems process thousands of transactions per second. For example, Visa Net the network used by Visa Inc. for processing global payment transactions processes on average 1.700 tps with tested capacity to process up to 65.000 transaction messages (*Visa Inc.* 2019).

Resolving this so called issue of scalability of the blockchain is essential for wider and faster adoption of the novice technology in the financial industry. The throughput time for transactions is important issue for organizations that consider blockchain solution for their accounting systems, particularly if single blockchain standard is to be followed in order to increase interoperability among many interconnected organizations. Another aspect of the scalability is the size and storage requirements, since a copy of the ledger with all transactions is maintained by each participant in the network. As the number of participants grows, the size of the ledger will grow to. For private permission ed as oppose to public blockchains, the scalability issue is less highlighted due to limited number of participants in the network and copies of the ledger. However, for large companies with many counterparties such as customers and vendors, even permission ed blockchain raises the need for more computational and storage resources.

One of the most promising solutions for the blockchain scalability issue is the Lightning Network (https://lightning.network/). It is a solution that acts as an additional layer to a blockchain that enables processing of multiple subsequent transactions between two participants off-chain through a direct channel. The blockchain capacity for processing transactions through the use of this solution could be increased to millions of transactions per second (Kokina *et al.* 2017, 94). Also, MIT and six other universities are working on a blockchain-based online payment system and new Unit-e crypto currency, with throughput of up to 10.000 transactions per second (Mearian 2019). This blockchain will use the proof-of-stake consensus mechanism that is vastly more efficient, with new ways of partitioning used to spread computational workload across peer-to-peer network. Until these promising solutions become available, the processing time of transactions is a limitation for wider adoption and accounting systems application of the technology. It is important for these initiatives for scaling the blockchain to have low enough costs compared to potential benefits of implementation of the scaled blockchain solution.

3.2. Transaction Costs

In order to verify transactions especially on public blockchains that use proof-of-work consensus, each node in the network performs the same tasks on own copy version of blockchain data. Thus, the proof-of-work is considerably inefficient compared to traditional ERP system for tracking accounting transactions, due to high consumption of computer processing power and electricity needed to process transactions (O'Leary 2017). This challenge could be solved if proof-of-stake verification method is implemented. In this consensus mechanism the transactions are not verified through dedicated computing power to solving a math problem.

Blocks are assigned for solving by participant in the blockchain based on probabilistic algorithm that considers the stake (wealth) of the participant (Kokina *et al.* 2017). Participants with greater stake or investment in the network have greater interest in protecting the network and preserving the value of stake. According to Dai and Vasarhelyi (2017), adoption of blockchain mechanisms in large corporate organizations will depend on development of large storage systems, wider bandwidth transmission and expansion in computer processing powers. Therefore, the management will need to evaluate what accounting data will need to go through the blockchain system in order to provide sufficient transparency and prevent excessive use of resources.

3.3. Interoperability of the Block Chain

Many businesses interact on a daily basis with considerable volume of transactions of moving value from one party to another, that need to be recorded in their separate ledgers simultaneously. Efficiency benefits are exploited if all parties are on the same blockchain or to put it more simplified to access the same database. As many blockchain systems are being developed for the parties to adopt, the problem of interoperability increases. In several industries, many blockchains are being developed individually by many different organizations and to different standards. Grewal-Carr and Marshall (2016) emphasize that this situation defeats the purpose of distributed ledgers, fails to harness network effects and is less efficient. The blockchain technology allows for transaction to be recorded simultaneously in the records of multiple transaction parties, if all parties have access to the same public database.

Even for tech eager companies, when a decision is made to implement a blockchain based accounting system, the company should assess how many of its clients and business partners will accept to participate in the

solution. Otherwise, the company can find itself operating double systems with reduced return on investment or underexploited benefits of the blockchain. The willingness of company's counterparts to participate in the blockchain and verify all transactions, not just those of their concern, is major consideration. They will need to see value in order to commit costly resources, thus a standard blockchain for the industry is more applicable. Industry wide move to a standard blockchain solution provides the promised core benefits of the technology for all stakeholders including vendors, customers, investors, auditors and regulators. For the bitcoin blockchain, participation is not an issue as nodes have genuine financial interest, since they are rewarded bitcoins each time they find a hash.

Professional accountants dealing with clients who deployed the technology have also highlighted the uncertainty arising from the dozens variants of blockchains and use case scenarios developed among each client (PWC 2017). Beside interoperability issues this is challenge for the regulators who also lag behind with regulatory standards for implementation of the blockchain technology in accounting and auditing. This will be the case until the adoption of the technology matures and less efficient and applicable versions disappear.

3.4. Confidentiality of the Block Chain Data

Public blockchain for recording accounting transactions increases transparency and credibility of financial information distributed to the general public. However, businesses are concerned with the privacy of the underlining transaction data and trade secrets. Transaction details are provided on the blockchain and multiple copies of the ledger exist outside of the company. The competition could have access and misuse customer and pricing information. The privacy and confidentiality of trade information is the main issue why many businesses are keener to explore incremental benefits of private blockchain and rather avoid use of public blockchains. Given the fact that public blockchains are more advantageous, many researchers propose possible solutions for the privacy issue.

According to Andersen (2016) decision could be made to replace original transactions in the blockchain with hashes that will retain the public consensus mechanism for confirming transactions without revealing the actual data of the transactions to third parties. Dai and Vasarhelyi (2017) propose another approach to secure transaction data privacy with two separate blockchain. The first is permissioned blockchain with restricted access for accountants, management, auditors and other parties that will be used for transaction verification. Verified and valid transactions should be encrypted, grouped into blocks and appended to the main blockchain which is public where users can view encrypted transactions and check the chain consistency. Wang and Kogan (2018) propose blockchain based transaction processing system that uses zero-knowledge proof consensus mechanism. The mechanism assumes the use of homomorphic encryption that allows for concealment of the actual data of the transaction, but computations can be performed by blockchain nodes for validation purposes without the need to decrypt the data.

Privacy of data is a special concern from regulatory perspective for blockchains that hold consumer data. This concern has emerged as major issue to greater blockchain adoption in Europe after the introduction of GDPR (General Data Protection Regulation) (Forbes 2018). GDPR requires companies to allow consumers to access their personal data, requesting for correction or deletion of data. Considering the immutable nature of the blockchain and absence of central authority over data records, new advancements need to be made to the blockchain technology and consensus mechanism, in order to allow for full compliance with GPDR requirements. In this sense, many large and global companies, including accounting firms has started open source collaboration in a project called Hyperledger (https://www.hyperledger.org/), on a track to develop stable frameworks, tools and libraries for advanced and business grade blockchain deployments. Hyperledger Fabric is distributed ledger software with modular architecture and consensus that offers user companies compliance with GDPR requirements.

3.5. Security issues with the blockchain technology

Many researchers and blockchain experts have agreed on some of the apparent governance problems of the public blockchains in which transactions are validated on a proof-of-work basis. The basic problem is the 51% attack where one participant in the network controls enough mining power to purposely change the consensus, software or validation of transactions in personal benefit at the expense of the others (Coyne and McMickle 2017, Rückeshäuser 2017, Yermack 2017, Kokina *et al.* 2017). For a public blockchain this kind of attack could be considered as very expensive strategy, but other approaches can also pose a threat for the network. Yermack (2017) describes types of sabotages of the network orchestrated by a single network member. For example, a single member could load faulty code and misrepresent its capabilities among other nodes in order to get verification. A prisoner's dilemma type of strategy could be devised, offering modest payment for uploading inferior software that worsens the position of other members in the network.

Main challenges for the blockchain technology are not concerned with network securities issues. Mougayar (2015) estimates that the blockchain in essence represents up to 80% change in business processes and 20% new technology implementation. The principle reasons for implementing a blockchain technology should not be searched amount particular problems that need to be solved in certain industries. Instead, the technology offers new ways of providing service, new collaboration patterns inside and between organisations. Even for organisations that have been through technology transformation, blockchain technology can be considered as powerful vehicle for reshaping organization's culture because it places authority and trust in decentralized network (Grewal-Carr and Marshall 2016).

3.6. Problems with smart contracts

Kokina *et al.* (2017) argue that even the use of smart contracts has its challenges, considering them computationally expensive and source of vulnerability of the system. Smart contracts are considered computationally expensive since miners have to complete calculations to trigger execution of the contract. There are security issues with smart contracts. One was the case of the DAO (Decentralized Autonomous Organization) attack where millions worth of ether tokens were stolen from the ethereum blockchain when a hacker exploited a "recursive call bug" in the smart contract code.

The technology has limitations in fully preventing fraud around transactions recorded by the accounting. Many researchers raised concerns about the hype that the blockchains are free of fraud (Coyne and McMickle 2017, Rückeshäuser 2017, Schmitz and Leoni 2019). Fraudulent transactions that do not match the real nature of relations established by transaction parties, could be encoded on the blockchain and verified if assumed logical by the nodes in the network. Also, the blockchain technology is expected to be as vulnerable to corruption and bribe schemes as traditional accounting system. Auditors will need to be cautious when perceiving the credibility of accounting information provided by a blockchain-based accounting information system. This means that they should not reduce the professional scepticism when performing audit in blockchain accounting environment, since there are no guarantees that blockchain information is completely free from fraud and errors.

However, incremental fraud benefits of the technology could not be fully disregarded since recorded fraudulent transactions on the blockchain become immutable. Covering of tracks is more complicated and tracing back suspicious transactions easier during later investigations. Smart contracts encoded on the blockchain following accounting and transaction rules could serve as efficient controls of business processes that additionally mitigate the risk of fraud.

Conclusion

Blockchain technology has surged as one of several present-day technologies designated to play significant part of so called industrial revolution 4.0. It has the potential to alter if not disrupt many business processes including the accounting and auditing profession (Dai and Vasarhelyi 2017). At first the technology gained considerable hype and considerable number of consortia projects have been initiated to exploit the technology, particularly in the financial industry for next generation trade finance and cross-border payments systems. Many projects target the global supply chain and try to make a use case for transaction digitization and tracking of origin of specific commodities. In the accounting sphere, the proponents expect the technology to practically introduce the paradigm of triple-entry accounting. It should result in increased transparency and trust in accounting information, less important role of third party intermediates and supervisory authorities (Dai and Vasarhelyi 2017, Schmitz and Leoni 2019).

However, some researchers have expressed views that current ERP systems in place allow for appropriate recording of transactions, including control and assurance that fits the expectations from the public (Coyne and McMickle, 2017). The systems are relatively cost effective and avoid some problems if immature blockchain technology is used, such as interoperability, privacy and scalability.

Since blockchain is at early stages of development with limited practical adoption in different industries, the impact on the accounting and auditing profession must be viewed wisely and carefully. Presently, a small portion of new entrants in the profession will need to equip themselves with skills to operate in a blockchain ecosystem as they steadily face business clients implementing the technology (CPA and AICPA 2017, Vaidyanathan 2017). As the blockchain receives much of it popularity within the financial services industry, it is essential for auditors that specialize in providing assurance services in this industry to investigate the common blockchain solutions developed for the industry. Only major accounting firms can dedicate resources to provide new services to clients and make the most of blockchain revolution by advising companies on the adoption and implementation of the technology.

In this paper we have identified the potential benefits and impact of the blockchain technology for the accounting and auditing, including implications for careers of professionals. The most obvious benefits relate to increased trust and credibility of accounting information, continuous more efficient and effective audit of financial statements and decreased risk of financial statements fraud. Despite the obvious benefits, we highlighted the main challenges for the technology, such as the issues of scalability, interoperability, confidentiality and security. We argued that addressing these challenges is not easy and limits the wider deployment of the technology in the near future.

Regardless of the state of the advancement of the blockchain technology, the overall trends are that the nature of accountants and auditors work will continue to change from frequent manual reconciliations towards technology supported automated procedures. In the immediate future the blockchain technology could not replace the annual financial reporting and audit of financial statements. The auditors will play important role providing assurance and credibility over financial reporting for the purpose of financing through banks and capital markets, mergers and acquisitions and regulatory compliance. The users of financial statements need auditors that will exercise professional scepticism and judgment in concluding whether financial statements taken are free from material misstatement and question accounting estimates made by the management.

Further research need to focus on real use cases of the blockchain implementation and provide evidence on the usefulness and true disruptiveness of the technology for the accounting profession. The economic case for the technology is important research question and currently there is a lack of quantitative research that will estimate the cost and benefits of adopting the blockchain. Also, studies that investigate the perceptions and experiences of professionals with the blockchain technology could provide guidance on future actions that need to be taken by academia and other professionals in order to keep pace with the trends in the development and application of the technology.

The governance of the blockchain network is another important research stream since the technology could find considerable accounting application if it can deliver increased trust and transparency by minimizing the involvement and costs of third party intermediaries. In this sense the relevant research questions are:

- What type of blockchain architecture, private-permission or public-permission less, is the most appropriate for accounting purposes?
- What kind of accounting information should be recorded on the blockchain in order to safeguard trade secrets for businesses?
- What will be the respective role of auditors or government authorities on the network?

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