BLOCKCHAIN APPLICATIONS IN THE ACCOUNTING DOMAIN

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Abstract

There is an increasing interest in blockchain or distributed ledger technology, which is reflecting the rapid development of the blockchain ecosystem. Many organisations like IBM, CommonwealthBank, Australia Post, etc. explore this technology and invest significant amounts in different blockchain projects. Their number currently exceeds 86,000 and will continue growing in the years to come. Applications of distributed ledger technology are identified in different industries – agriculture, government, transport, and financial services. Basically, they represent solutions for transaction record keeping and most of them so far have been in financial services.

From the accounting perspective, blockchain is wildly considered as a fundamental change in the accounting domain as it introduces a new way the accounting records are generated, stored and updated. Some experts even argue that it is an accounting technology as it is a platform for doing business and accounting with a huge impact on the accounting profession.

In this paper we address few of the challenges facing the accountancy profession due to the recent information technology advances and their augmented business application. Our ultimate goal is to shed light on the potential implications of blockchain for the accounting professionals as distributed ledger technology is a shift from the conventional accounting and is fundamentally changing organization and functioning of the accounting systems. We also provide some insights on the regulatory landscape and identify few of the pending regulatory issues that might give rise to a variety of accounting implications.

Few profound studies are used as a focal point of our attempts to better comprehend the diversified impact of blockchain technologies on the accounting domain. We contribute to this research strand by focusing on the accounting perspective and putting more emphasis on the blockchain applications in accounting.

Key words: *blockchain, applications, accounting domain, accounting profession, regulatory aspects.*

"Blockchain is the most significant innovation
in bookkeeping since double-entry accounting
was introduced over 700 years ago"

Juerg von Kaenel,
Associate Director at IBM Research Australia

1. INTRODUCTION

Bitcoin was the first and still most popular implementation of a broader class of blockchain technologies. The latter support cryptocurrencies but they have many other applications and implications. The relationship between Bitcoin, blockchain and distributed ledger technology is represented on figure 1. Evidence form practice show that they are used in an array of different fields for varying purposes. Blockchain as an example of distributed ledger technology is wildly considered as a significant innovation in traditional record keeping based on its use of both cryptographic tools and a distributed consensus process (CAANZ 2017).

From the accounting perspective, blockchain brings a fundamental change in the accounting domain as it introduces a new way the accounting records are generated, stored, and updated. Though initially associated with Bitcoin, which indeed made this technology extremely popular, some experts argue that it is an accounting technology as it is a platform for doing business and accounting (ICAEW 2018, pp. 2-3) with a huge impact on the accounting profession. Indeed, blockchain is one of the most well-known implementations of the distributed ledger system. The recent rapid development of the blockchain ecosystem reflects the great potential implications of this novel and unique technology though we ought to admit that cryptocurrencies are still the most popular use case. Corporate decision makers' attempts are primarily focused on identifying and assessing the business applications of blockchain as well as on evaluation of the associated benefits and risks. Businesses could substantially simplify their operations, reduce fraud, and achieve greater transparency of their activity. Moreover, the need for duplication and verification of records within organizations will be significantly reduced (CAANZ 2017). According to Cermeño (2016), a whole new generation of services could emerge. Applications of distributed ledger technology are identified in different industries - agriculture, government, transport, and financial services. Basically, they represent solutions for transaction record keeping and most of them so far have been in financial services. However, more opportunities arising from the broader adoption of distributed ledger technology in the banking and payments systems should be explored (European Securities and Markets Authority 2017).

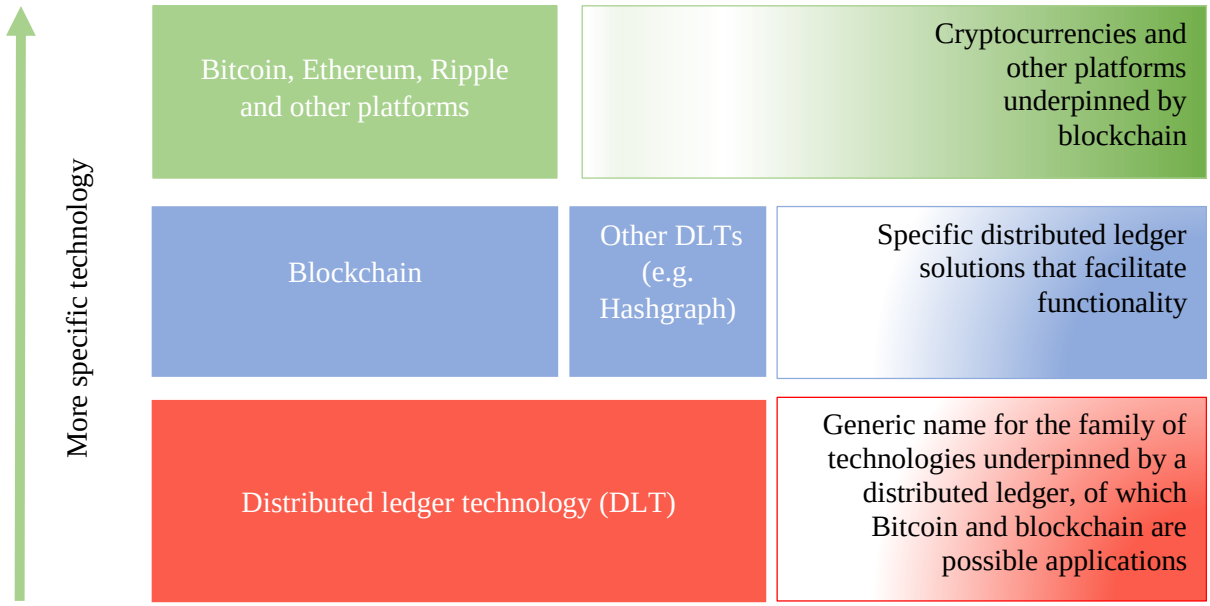

Figure 1. Distributed ledger technologies

Source: (CAANZ 2017, p. 8).

Blockchain is a shift from the traditional bookkeeping characterized with organized central controlling to guarantee data trustworthiness. With the use of one single ledger, reconciliation between counterparties is avoided, costs savings are realized, and efforts of the transacting business parties are significantly decreased. As the blockchain method allows for granting view-only access, third parties as regulatory bodies, tax authorities, etc. could perform a real-time monitoring of transactions leading to cost savings and enhanced efficiency of regulatory and compliance activities (ICAEW 2018). For accountants it is an opportunity to improve their job efficiency. First, costs associated with the maintenance and reconciliation of accounting ledgers could be extremely reduced. Second, certainty over the measurement of rights and obligations over assets might be significantly increased (ICAEW 2018). The accounting professionals have the required skills and abilities to become leading partners in

organisations as they can support the management in developing blockchain-led business solutions and services.

Beside the many opportunities for the accounting experts associated with the distributed ledger technologies, there are also many uncertainties and challenges. For instance, there is a whole host of regulatory issues requiring urgent decisions by the policy makers. The arrangement of the legal status of blockchains and distributed ledgers such as territoriality and liability requires a development of a relevant legal framework. There are many legal aspects of cross-border sharing of information and data protection that also call for special regulations. Another challenging issue are the so-called 'smart contracts'. Their specific features as real-world enforceability, territoriality and liability should be address and legally arranged.

2. AIM OF THE PAPER AND RESEARCH METHODOLOGY

In this article we address few of the challenges facing the accountancy profession due to the recent information technology advances and their augmented business application. Our ultimate goal is to shed light on the potential implications of blockchain for the accounting professionals as distributed ledger technology is a shift from the conventional accounting and is fundamentally changing organization and functioning of the accounting systems. There will be changes in the work patterns leading to new employers' requirements for the professional qualification of the future accountants. We also provide some insights on the regulatory landscape and identify few of the pending regulatory issues that might give rise to a variety of accounting implications.

We use an interpretive and critical methods approach to accomplish our research goal. Findings and conclusions of few profound studies are used as a focal point of our attempts to better comprehend the wide-ranging impacts of blockchain technologies on the accounting domain. We contribute to this research strand by focusing on the accounting perspective and putting more emphasis on the blockchain potential applications in the accounting field. However, as the distributed ledger technology evolves and new uses and implications emerge over time, the newly revealed potential of the blockchain might further impact the accounting realm by improving accounting techniques, expanding accounting services and bringing innovative solutions to businesses.

3. BLOCKCHAIN FEATURES

It seems that the history of blockchain has started in October 2008 with the programmer (or programmers) known under the pseudonym 'Satoshi Nakamoto', who developed a technology underlying Bitcoin – the first digital currency. It was a decentralized peer-to-peer network, a specific shared data structure, requiring a special consensus to be applied (Nakamoto 2008). The latter comprises of a set of rules that have to be followed so as to validate a transaction. Validation of the changes in the blockchain database is performed through development of special algorithms for distribution of responsibility in the network. The use of encryption for data validation and 'fingerprint' enhances security and trust in the blockchain.

It is exactly this decentralized trust that makes blockchain supporters so enthusiastic about its business applications. For instance, under the conventional centralized banking model, if entity A transfers 1000 EUR to entity B, the bank validates the transaction thus confirming the transacting parties and other details. Entity A's account is debited 1000 EUR and entity B's account is credited 1000 EUR. In this case, the bank is playing the role of a central authority and keeps a single copy of the ledger. Historical data of past transactions as well as information about the current account balances are stored only by the bank. In contrast, under the distributed ledger approach, if entity A transfers 1000 EUR to entity B, each of them will have identical copies of the ledger and the payment details. All members to the payment network have identical copies of the ledger and validate the transaction through a consensus algorithm. As a result, entity A's account will be debited 1000 EUR and entity B's account will be credited 1000 EUR (J.P.Morgan 2018).

Once the transaction is verified with computer algorithms by approved nodes from the network, a new block is created and added to the register of all previous verified blocks – the blockchain. The blockchain process is illustrated on figure 2.

There are some distinguished characteristics that make this novel technology so unique. Many individual researchers and professional organization have made their attempts to analyze and summarize them. Based on our literature overview and the comparative analyses performed, we argue that these characteristics are quite similar but expressed in different terms[1].

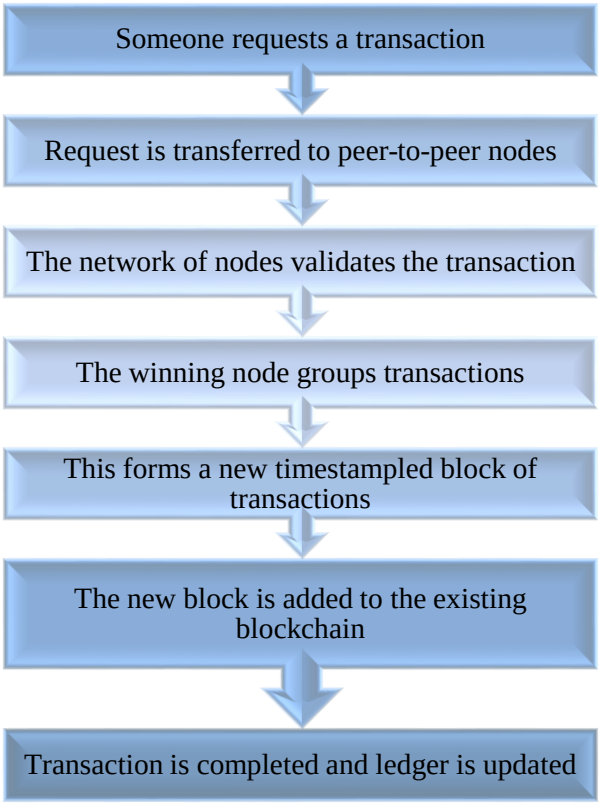

Figure 2. Blockchain process

Source: (CAANZ 2017, p. 9) and (Bonsón and Bednárová 2019, p. 734).

The World Economic Forum (2016) outlines three key value propositions for blockchain – veracity, transparency, and disintermediation. Veracity is expressing the specific way of verification of the historical record of ledger entries by consensus. Transparency, listed as the second characteristic of the technology, aims to express the publicity of activity records as they can be seen by all market participants. Disintermediation is associated with the lack of specific central organization. Instead, distributed ledger technology operates by using a peer-to-peer network. It is the lack of central validating authority that makes this system so unique. This is the core feature of distributed ledgers as it initializes all the benefits associated with this technology. Overcoming the need for a third party might be of considerable benefit especially in cases when the costs for supporting trusted central organization are high. If compared to the centralized ledger, it is characterized with higher security as it is less vulnerable to online attacks (CAANZ 2017). However, the lack of a single central organization as a benefit must

[1] For instance, both veracity (WEF 2016; CAANZ 2017) and permanence (ICAEW 2018) refer to the consensus as the specific way to verify the truth of the transactions recorded in the ledger. Furthermore, programmability (ICAEW 2018) features the smart contract, which according to Cermeño (2016) is the most promising characteristic of blockchain.

be considered with the needed caution. It requires verification of transactions to be performed by multiple peers and such duplication could be expensive.

According to a publication of the Institute of Chartered Accountants in England and Wells (ICAEW), blockchain characteristics could be explained by "the three P's" key terms – propagation, permanence, and programmability (ICAEW 2018). The first one, propagation, refers to the many copies of a blockchain ledger and the lack of one single 'master' copy. Every party has an identical and equivalent copy and an unlimited access to a full copy of the ledger. No one has control over the latter. All new transactions are quickly posted and propagated to all participants' copies. Permanence, the second characteristic, is related to the specific way the truth is determined – by consensus. Transactions edited in the ledger are permanent and information cannot be changed or deleted without the permission of the majority of the participants. Inspection and verification of the ledger could be easily performed as it is stored by each party. The third feature, programmability is associated with the so called 'smart contracts' that use blockchain as a platform for achieving simplification, automation and certainty of transactions and contractual arrangements.

According to a definition, a smart contract is 'a computer program intended to digitally facilitate, verify, or enforce the negotiation or performance of a contract. Smart contracts allow the performance of credible transactions without third parties. These transactions are trackable and irreversible' (J.P.Morgan 2018, p. 19). Indeed, some blockchains are designed in such a way that program code as well as ledger entries might be stored on them which makes them examinable by the contracting parties. When triggered, journal entries are created and executed automatically (ICAEW 2018). Depending on the contract's own terms, its automatic execution might lead to a payment, an investment, etc. One advantage is the risk reduction among the counterparties as well as the disintermediation. The latter should be considered with caution as there is still a need for a trusted professional – a programmer, who has to create the smart contract. The functioning of a smart contract is presented on figure 3.

Distributed ledgers might be structured, managed, and maintained in a variety of ways depending on how much the participants in a network are trusted. Two types of blockchain networks have been identified: permissioned and permissionless. The former is those with a limited number of trusted entities validating transactions. Only they are given the permission to join the network. The latter describes a type of networks with no required permission for validation of transactions. Consequently, any individual can validate transactions. There is a possibility for the transactions to be validated pseudonymously (Capgemini 2015).

Cermeño (2016) emphasizes that blockchain could be a universal shared and trustworthy 'database' stored in a tamper-proof way that could be used as basis for developing new industry process. The researcher outlines several disruptive features of this technology and refers to smart contracts as the most promising characteristic.

4. IMPLEMENTATION OF BLOCKCHAIN TECHNOLOGIES

Blockchain is an emerging technology with a significant potential for more practical though sometimes more sophisticated implementations compared to Bitcoin being its original and still most popular application. However, its potential should be revealed and comprehend without biases and speculations. Applications depend on the prevailing technology elements. Distributed ledgers could be structured, managed, and maintained in different ways leading to a variety of technology implications. A common feature for their differentiation is the degree of trustworthiness to participants in a network. (CAANZ 2017)

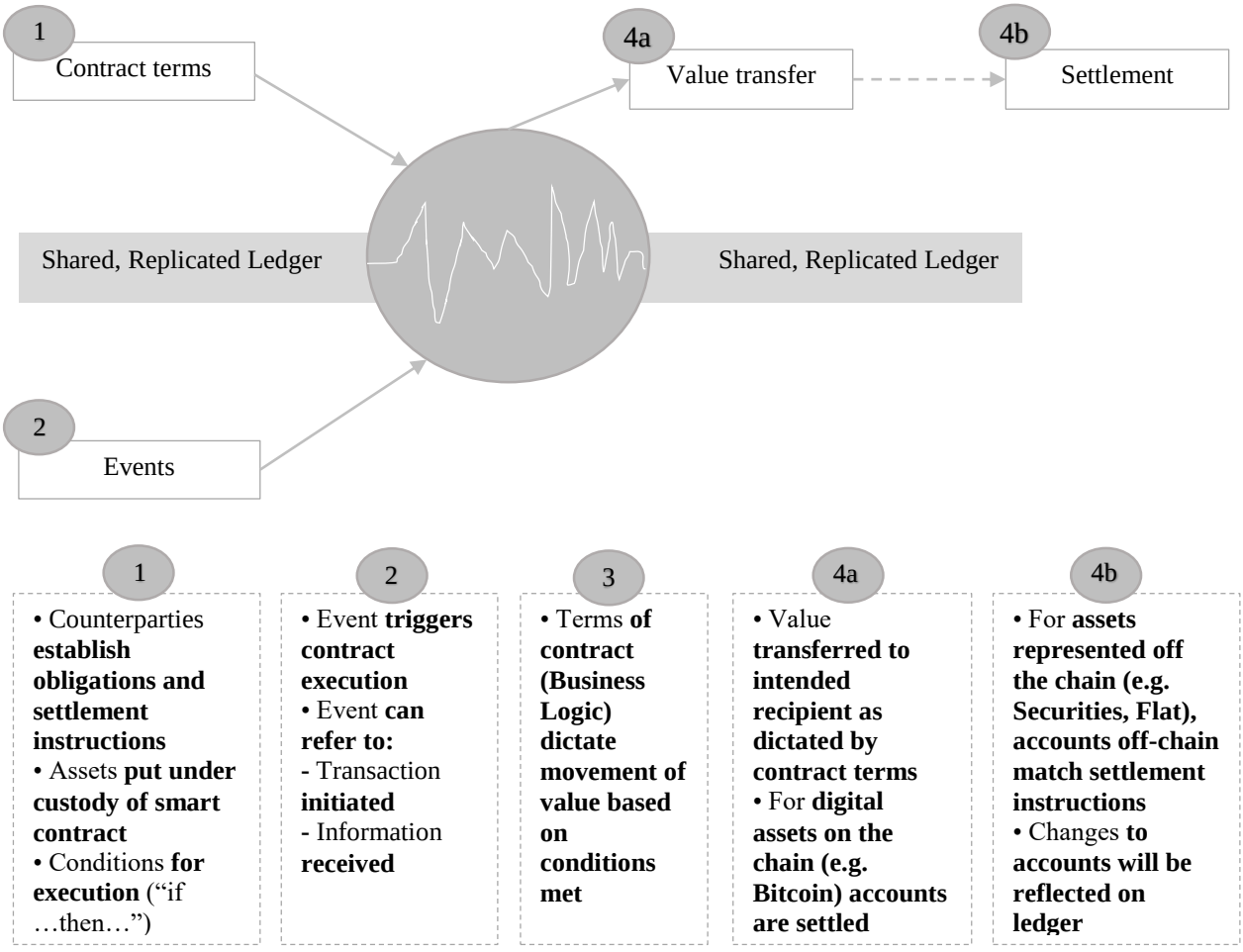

Figure 3. Applying business logic with smart contracts

Source: (Cermeño 2016, p. 6).

Mark Staples, a principal researcher at the Commonwealth Scientific and Industrial Research Organisation's Data61, the largest data innovation group in Australia, considers blockchain as a database system facilitating commercial and social relationships. He claims that complex markets with multiple participating and interacting organizations provide a blockchain-enabling environment resulting in many effective uses of the technology. Bonsón and Bednárová (2019) outline few of the general benefits associated with blockchain though they affirm that more empirical evidence is needed for their confirmation or rejection. Reduction of economic uncertainty is one of the benefits in the researchers' list, followed by the decrease of agency costs and information asymmetry. As distributed ledger technology makes every computable transaction easily verifiable, it augments agents' accountability thus minimizing agency costs. Moreover, all transactions are visible to every node in the architecture, leading to enhanced transparency. Hence, following the basic principle of the agency theory, information asymmetry between the transacting parties will be reduced because of the increased transparency and accountability. In addition to the benefits outlined herein, the co-authors point out the increased auditability, trust, and reliability of data. Furthermore, the quality of the latter will be substantially improved. Bonsón and Bednárová (2019) refer to the qualitative characteristics of information as required by the International Financial Reporting Standards. They argue that completeness, interpretability and clarity, relevance and comparability of company financial statements will be improved as a result of blockchain applications. Next, this technology might solve a pending problem with data privacy, referred to as 'the privacy paradox', as it enables an effective identity management

by allowing sharing only the necessary information for a transaction (Tapscott and Tapscott 2016). An additional benefit is the supply chain transparency that might be achieved, as the 'story' of an asset is easily traceable and asset information could be digitally transferred across the supply chain thus making the origin of the asset and all its subsequent transformations visible to all nodes on the blockchain. Another proponent of blockchain technology, Rob Hanson, a senior research consultant at the Commonwealth Scientific and Industrial Research Organization, reckons that blockchain is a suitable solution as it removes the need for a third party to act as an intermediator for transactions and relationships under existing systems. As a result, costs and friction in processes might be reduced (CAANZ 2017, p. 15).

Despite the positivism, expressed by many experts in the fields and the benefits associated with distributed ledger technologies, the latter have to be applied with caution as currently most of the aforelisted benefits are not supported by empirical evidence (Bonsón and Bednárová 2019). Mark Staples also argues that blockchain solutions should be implemented carefully and every case should be approached with the needed caution.

Basically, blockchain applications could be divided into two groups based on the core functions of the technology. On one hand, transacting without the need of central authority makes blockchain applicable for the development of new forms of payments and settlements. On the other, there are many practical uses of this technology as an immutable ledger as it could be applied for record keeping of data that cannot be modified after being created. Some blockchain applications are summarized and presented in table 1. The list is not exhaustive, and they should be considered with caution as many of them are still in their conceptual phase or under development.

Table 1. Blockchain applications

Applications of blockchain:	
for payments and settlements	**as an immutable ledger**
In banking: • for interbank reconciliation, especially useful for very complex group structures and huge volume of intergroup transactions • for interbank transfers of value • for speeding up international transfers by real-time settlement using smart contracts, leading to increased profitability • for replacement of the international money transfer system (still as a project) • for payment transfers between subsidiaries resulting in cost and time reduction in transferring funds	*For supply chain optimization:* • for tracking goods through the supply chain thus providing reliable path back to their origin • for tracking high-value items through complex supply chains • increased transparency and reduced counterparty risk • with built-in smart contract payments to be made as soon as goods are delivered or ownership changes • improved audit capabilities
Applications to security markets: • as a clearing and settlement system, aiming to enable near real-time settlement of certain securities transactions and reduce administration costs (still as a project) • for enhancing reporting and supervisory function, incl. increased traceability of transactions • for greater security and availability • for reducing counterparty risk and enhancing collateral management	*For healthcare improvement:* • sharing personal health records securely according to exact rules • improving and authenticating the delivery of services

Other business applications: • for making payments without intermediation of a third party (cryptocurrencies) • as a trading platform for cryptocurrencies • for cutting out retailers thus providing opportunities for producers and consumers to trade their goods directly and overcoming the addition of market costs and commercial margins (currently under development in the energy sector)	*Other business applications:* • as a public ledger of transactions for virtual currencies, such as Bitcoins • for storing digital identities • for building an e-voting system • for improving hotel booking efficiency by using smart contracts (in tourism)
In the public sector: • to help governments to collect taxes and deliver benefits	*For government and regulatory purposes:* • to help governments to issue passports, record land registries, assure the supply chain of goods and generally ensure the integrity of government records and services. • for regulatory compliance

Source: Author's elaboration based on: (CAANZ 2017), (UK Government Office for Science 2016), (ICAEW 2018), (J.P.Morgan 2018), (WEF 2016).

Blockchain has a potential to be combined with other technologies. New opportunities for technology application arise and challenge practitioners and researchers to exploit their practicality and efficiency. For instance, the Commonwealth Bank of Australia used a combination of blockchain, smart contracts and the internet of things to facilitate the financing of a trade transaction. We consider this as a new research stream which requires more focused efforts from academia.

We will present several primary use cases with different current implementation status. Some are designed as pilot proof-of-concept projects and are still in their development phase. Others have already been implemented and gained enviable popularity as Bitcoin, considered the 'most media-friendly implementation' of blockchain (J.P.Morgan 2018, p. 1).

Bitcoin

Bitcoin is the first cryptocurrency and is still the most popular among the rest, currently exceeding 5780, as it dominates the market with a share of 61.1 percent[2]. Being the first electronic payment system, it overcomes the need for a trusted third party by allowing a direct transaction between any two willing parties. The main goal of Bitcoin creator, known as Satoshi Nakamoto, was to avoid some of the risks associated with the traditional payment system as high transaction costs, fraud and personal data leakages. Bitcoins in existence will never exceed the number of 21 million. It is probably its artificial shortage that makes this cryptocurrency so unique as well as the process of value creation and miners are at the heart of it. By using hardware, they process the blocks and are rewarded with Bitcoins. The lifecycle of the digital currency is illustrated on figure 4. Some of the benefits and challenges associated with Bitcoin are listed below (Stancheva-Todorova 2020).

Benefits of businesses moving to the Bitcoin system: 1) lower transaction fees if using cryptocurrencies as a payment option; some small charges for converting cryptocurrencies into local currencies; 2) instantaneous transfer as payments with cryptocurrencies are processed immediately, which is a serious incentive for their business-to-business transactions; 3) businesses are improving their competitiveness internationally by reducing the cost they incur for accepting currencies and their processing; 4) fraud prevention and reduced liability associated with the misuse of customers' personal information.

[2] Retrieved from https://coinmarketcap.com/charts/ (Viewed 25 July 2020).

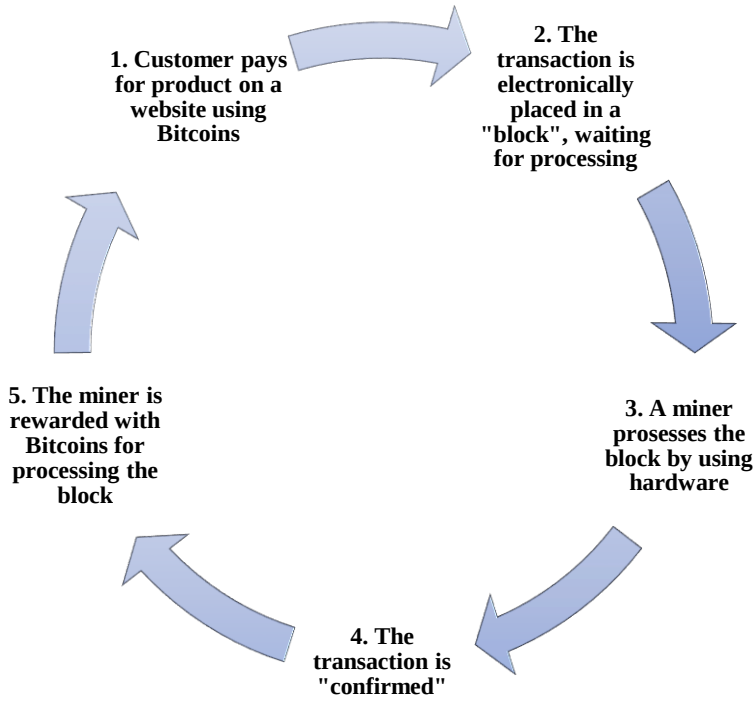

Figure 4. The lifecycle of Bitcoin

Source: Author's elaboration based on (CAANZ 2015, p. 12).

Challenges associated with the implemented risks: 1) threat of hacking and stealing details of cryptocurrency wallets; 2) lack of privacy due to the ability of tracing the IP address; 3) lack of world-wide accepted specific regulations; 4) many tax implications and other challenging issues are still not addressed.

Initial coin offerings

Through the so called "Initial Coin Offerings" (ICOs) companies gain access to new capital sources to enhance their investments and finance business expansion. Blockchain technology has facilitated the creation of a new asset class that potentially might be considered as a new form of capital. As a fundraising opportunity, ICOs represent value that could reflect a physical asset, for instance a real property or an intangible as a copyright. Moreover, similarly to the smart contracts, these structures might have some dynamic characteristics complementing their features as static value representatives.

It is the potential network effect of a successful coin that attracts investors as many of the ICOs are issued without an embedded option for receiving a principal or interest as a return. Hence, they do not have the characteristics of a debt. Furthermore, ICOs do not offer voting rights or some forms of dividends as the conventional equity instruments. The accounting treatment might vary from case to case and basically depends on the exact circumstances. ICOs are accounted for as debt, equity, or deferred income by issuers (J.P.Morgan 2018).

Benefits of ICOs: 1) a rapid fundraising opportunity especially for the start-ups; 2) some transaction costs associated with marketing to investors, regulatory compliance, and security registration are avoided; 3) traditional intermediaries are avoided; 4) unexploited potential for companies with large user-based network as Visa, Facebook, WhatsApp, Apple, etc. not only as a source of capital but also for expanding their clients network.

Challenges: 1) many regulatory uncertainties; 2) ICOs lack the official approval by the security markets authorities; 3) legal definitions, accounting standards, and tax treatment are needed.

Land register

Land register is really a good use case to consider as blockchain is concerned with the transfer of ownership of assets and distributed ledger of maintaining trustworthy financial information. Implementation of the technology requires creation of digital assets, legally equivalent to the land assets, that should be included in the register. After land assets tokenization, tokens should be assigned to the present landowners and their ownership of the appropriate tokens confirmed. Compared to the bitcoin, which is a wholly online system with the ownership agreed by all participants in the network, land register is facing some challenges. Some of the benefits and challenges of this blockchain application are summarized below.

Benefits:1) publicity is not an issue due to the open visibility of the blockchain – all participants could see who owns and sells the land; 2) increased security as a result of the clear and permanent record of ownership and ownership transfers; furthermore, availability of data will not be affected by server failures, downtime, etc., because of the distributed nature of the ledger; 3) increased transparency as a result of verifiability aspect of the implemented technology; 4) decreased corruption due to the expanded transparency on land ownership and transactions; maintenance of records is distributed to all parties; 5) increased liquidity of the land market as a result of the increased security and decreased corruption.

Challenges: 1) the register should reflect the real-world existence and condition of the assets complementing the ownership information; 2) the enforcement of ownership rights needs a legal mechanism calling for urgent government regulations.

Land register application of blockchain technology is still in its conceptual phase of development. There have been several pilot proof-of-concept projects in Honduras, Georgia and Sweden but unfortunately not leading to any practical implementations despite the unarguable benefits. (ICAEW 2018).

Von Kaenel expects more widespread adoption with the development of the blockchain technology and companies' business models. He argues that many businesses are still experimenting by running blockchain systems in parallel to existing systems, but still as a check. In his vision, in 10 years' time, blockchain will become an integral part of how businesses operate and will not be a subject for discussion. (CAANZ 2017, p. 23).

5. BLOCKCHAIN CHALLENGES FOR ACCOUNTING PROFESSIONALS AND ACCOUNTING EDUCATORS

5.1 Some blockchain tools applications and implications in the accounting domain

Mark Staples argues that 'blockchain has its origins in accounting; it is a technology built around an auditable record of financial transactions' (in CAANZ 2017, p. 15). It is undisputable that blockchain has a great potential and might significantly transform accounting and audit realms, though, there are many challenging application issues that should be tackled. Zhang et al. (2020) summarize the most significant impacts of blockchain implementations in the accounting domain based on a variety of publications on this hot topic. They managed to align every listed potential impact with an associated goal. For instance, the prove of ownership might be guaranteed as the accounting information stored in the blockchain is traceable and non-tamperable, meaning that it cannot be falsified. The technology allows a trustful verification and authorization for assets, including intellectual property rights, agreements, etc. (Wang and Kogan 2018). Another potential impact on accounting is the improved transparency of accounting data, due to the decentralized nature of distributed ledger technologies. The next goal that might be accomplished is the clear order of transactions leading to permanent and reliable accounting information that is easily traceable and difficult to be changed. Further, due to the required network consensus, transaction clearing or settlement might be achieved in real-time thus improving accounting efficiency. Moreover, accounting business processing could be further rationalized due to blockchain programmability and the existing opportunities for setting algorithms or rules.

According to a breakthrough research on blockchain conducted and compiled by Deloitte (2018), the technology has the potential to lower the risk of fraud, increase efficiency, improve customer loyalty, as

well as make an organization smarter. Smith (2018), an advocate of the continuous accounting concept, argues that blockchain could make accounting data and financial reporting information available in a secure and continuous manner to regulators, tax authorities and other external end users. Hence, communication with stakeholders might be significantly improved in terms of timeliness and transparency and more comprehensive reporting could be provided to market participants.

Wang and Kogan (2018) propose a design for a transaction processing system that is based on blockchain, zero-knowledge proof, and homomorphic encryption. The researchers demonstrate its application in real-time accounting, continuous monitoring, and fraud prevention.

Bonsón and Bednárová (2019)[3] affirm that blockchain enables implementation of the concept of distributed consensual accounting records into accounting practice for the benefits of continuous accounting, auditing, and reporting. Participants of the block, the nodes, might be suppliers, clients, auditors, tax authorities, regulators, etc. Once they approve a transaction, it is registered and everyone in the network has a copy of the ledger. The trustworthiness of accounting data is guaranteed due to cryptography and immutability of every entry, which is stored in multiple places.

Blockchain advances might be used for implementing the triple-entry bookkeeping method thus facilitating continuous accounting and near-real-time auditing. In contrast to the traditional financial accounting, based on a double-entry system, the triple-entry accounting requires a third party, an independent intermediary, to authorize every transaction for recording the entry into the ledger (Kiviat 2015). This method is publicly announced some decades ago and is considered an enhancement of the double-entry bookkeeping. Through this mechanism, the two parties involved into a transaction are guaranteed that both sets of accounting data are congruent. With the blockchain deployment in the accounting domain, one significant disadvantage of the triple-entry method is overcome as there is no need to support two separate sets of accounting records. Further, there is a cost saving, associated with the involvement of a third party. As every transaction is cryptographically sealed, subsequent modifications of accounting data are impossible, which makes accounting records permanent and hence, trustworthy.

5.2 Blockchain for accounting purposes – some implementation milestones

The design of blockchain ecosystem

The design of an appropriate blockchain architecture for accounting purposes is one of the practical implications of this disruptive technology. Bonsón and Bednárová (2019) outline several aspects that should be considered in this regard as the careful selection of nodes, the structure of database, authorization, verification protocols, etc. They propose a simplified version of a company blockchain ecosystem with private permissioned architecture. The nodes might vary from suppliers, clients, banks to the public administration authorities and the auditing company. The design has to allow sharing of the ledger with all the nodes of the network. By using cryptography, the access of every node might be limited to the use of the relevant information only.

A well-designed blockchain ecosystem has many benefits for both internal and external stakeholders. On one hand, company's management will have full access to accounting data that is continuously updated. The timeliness and improved quality of accounting information and the real-time financial reporting will enhance their usefulness for decision-making purposes. Furthermore, blockchain tools might allow some employees to receive limited access to only a part of the information according to their role and functions within organization. On the other hand, external users as investors and creditors could make more informed decisions especially if other technology advances are implemented to incorporate big data from different sources.

The design should allow the embedding of smart contracts for automation and monitoring of processes. According to Dai and Vasarhelyi (2017), if integrated with internet of things technologies, the

[3] The researchers initially presented this idea in their former study 'Blockchain y los registros contables consensuados compartidos (RC3)', Revista de la Asociaci_on Española de Contabilidad y Administraci_on de Empresas, vol. 123, pp. 4-5.

bookkeeping process might be automated. The possible automation of bookkeeping is also discussed in the special study on blockchain and the future of accountancy, conducted by ICAEW (2018). Indeed, smart contracts have many potential applications that might reshape the accounting ecosystem. For instance, they could be used for supporting the HR function within the company or facilitating the work of tax authorities. Furthermore, company tax filings could be automatically generated and sent to the tax officer in charge. Next, budgets and company performance goals might be 'coded' into smart contracts and tracked to actual results for efficiency and management evaluation purposes. In addition, Alsaqa et al. (2019) argue that non-financial reporting, as environmental reporting, could also be encouraged by the implementation of smart contracts.

The regulatory landscape

Many regulatory issues related to blockchain implications are still not under scrutiny. There is an urgent call for a relevant, internationally applied regulatory framework that covers different legal aspect of distributed ledger technologies and is updated on a regular basis. It should become a priority in the working agenda of the policymakers, regulators, and supervisors. European Commission has already made its first attempts towards the development of common and unified rules on blockchain implications by implementing some regulations into its anti-money laundering directives. Some national jurisdictions have also taken few small steps in the same direction but due to the specific features of some components of the distributed ledger technologies and their specific applications, we still miss globally accepted legal solutions.

Beside the pending general regulatory challenges, the required but currently missing regulatory landscape of blockchain technologies in the accounting domain is still an issue. Regulatory bodies must be comfortable with the achieved levels of transparency of the processed transactions and quality of accounting data generated by accounting information systems with embedded blockchain tools. For example, Coyne and McMickle (2017) argue that blockchain provides limited verification of transactions, which is not sufficient and acceptable for accounting purposes.

Some discussions on the pending regulatory issues in a broader context are gathered and provided in the next section of the paper.

Security concerns

Confidentiality in the public blockchains as well as the threat of manipulation of private blockchains should be tackled to exploit the technology potential for accounting and financial reporting purposes (Coyne and McMickle 2017). Unauthorized security breaches might compromise the trustworthiness of accounting information and hinder the decision-making process by internal and external users. Solving these issues is predominantly a matter of implementing the relevant technology tools to maximize cybersecurity of the blockchain architecture.

Standardization of blockchain technologies

To amplify the implementation of blockchain, the technology requires a development of standards that should be approved globally. These standards should cover terminology, privacy, and security issues. Interoperability between systems is another problem that could be solved through standardization. The current lack of standards might be a serious challenge to companies from a single supply chain as every member could apply different types of blockchain technology. That brings inefficiency into the system and limits operational efficiency gains as every company must support multiple blockchain databases. Standardization, on the other hand, will result in time and cost savings, automation, and faster data availability. It '…would improve interoperability across systems and market participants, but also reduce counterparty concentration, operational and legal/regulatory risks for transactions that use blockchain technology' as stated by Frank Cerveny, a senior analyst at Moody[4]. The well-known business, and financial services company, has predicted in a report, issued in 2019, that blockchain technology will probably be standardized by 2021. This view is quite optimistic as standardization requires a certain level of maturity of this disruptive and promising emerging technology (Coyne and

[4] https://cointelegraph.com/news/research-blockchain-technology-to-be-standardized-by-2021

McMickle 2017). Hence, it is a very challenging issue for the standards setters as the International Organization for Standardization that started this initiative.

The Standards Association at the Institute of Electrical and Electronics Engineers (IEEE SA) is another globally recognized standard-setting body that is currently focusing its efforts on standardization of blockchain technologies. It has initiated a variety of activities in many industry sectors as agriculture, healthcare, pharmaceutical industry, etc. For instance, IEEE SA has launched the first Advancing HealthTech for Humanity™ virtual blockchain workshop.[5] Among its recent blockchain standards activities are the Clinical Trials EU Forum and the first detailed study of blockchain adoption in the pharmaceutical enterprise (for further reading, visit: https://blockchain.ieee.org/standards).

From an accounting perspective, accounting regulators and standard setters should consider the impact of digital ledger technologies on companies'accounting and financial reporting and set up rules and standards for blockchain to ensure reliable and transparent information for users (Stancheva-Todorova 2020). There are still many pending issues that hurdle implementation of blockchain tools and platforms for accounting purposes.

Intra-organizational challenges

Implementation of blockchain tools requires a profound cost-benefit analysis. Financial implications of the technology refer to the required investments in terms of financial and human resources. According to the blockchain application roadmap, provided by Deloitte[6], the company has to assess every use case in the context of an evaluation framework. The expected return of the blockchain project (viability), as well as its feasibility and alignment with company's business (desirability) should be carefully considered by the management. The willingness of the latter to be in tune with recent technology advances and implement innovative approaches for expanding business opportunities and competitive advantages is vital for the success of every blockchain project. In the Deloitte's 'proof of concept' phase, defining the team is an important step in the implementation process and accountants might play an important role due to their technology skills and competences, complementing the required accounting proficiency (Stancheva-Todorova 2019). They could provide valuable consulting services to support the management team initiatives and decisions and the blockchain experts. Further, they could use their financial literacy to perform the cost-benefits analysis. The expertise of accounting professionals needs to be enhanced to cope with some of the challenges associated with blockchain technologies and their augmented business application. One important question is what are the new skills and abilities required of accountants to benefit from deployment of distributed ledger technologies and create more value to the businesses. They do not have to be familiar with all technology details as they will not become engineers but should be able to consider all significant aspects of blockchain and evaluate its impact on businesses and their clients. We argue that the depth of knowledge depends on the use case, management innovation strategy, organization size, and investment policy. It is important to note that blockchain is already included into the syllabus of ICAEW ACA qualification (ICAEW 2018).

5.3 Blockchain achievements by the Big Four accountancy firms

The Big Four accountancy firms have started a variety of initiatives, including with professional organizations as the American Institute of Certified Public Accountants (Kokina et al. 2017), and are currently involved in many projects exploring distribute ledger technologies and their implementations. They are summarized and presented in table 2.

In 2016, Accounting Blockchain Coalition (ABA) was founded with the aim to educate and help businesses and organizations on accounting matters related to digital assets and distributed ledger technology, including blockchain. The Coalition members comprise of a diversity of professionals working in the fields of accounting, advisory, audit, tax, law, higher education, regulatory, risk, or technology[7]. Since its establishment, this organization has hosted many events as conferences and

[5] https://blockchain.ieee.org/standards
[6] https://www2.deloitte.com/us/en/insights/focus/tech-trends/2018/blockchain-integration-smart-contracts.html
[7] https://accountingblockchain.net/

webinars and launched several initiatives trying to create best practices and leading the change of the accounting industry caused by the emerging technologies and their augmented application.

ABS initiated an annual Blockchain, Accounting, Audit & Tax Conference as well as special conferences on virtual currencies implication issues. Three working groups have been formed that are currently working in the fields of audit and accounting, internal controls, and taxation. One of their tasks and urgent priority is to cooperate with standard setting bodies for development of a set of accounting standards aiming to regulate the use of blockchain technologies (Del Castillo 2017).

Table 2. Blockchain applications by the Big Four companies

Company	Achievements in blockchain applications
Deloitte	• It developed the first blockchain based software platform Rubix, that allows company's employees and clients to build customized blockchain and smart contract applications for different use cases (Minichiello 2015). The platform is designed with four application areas: 1) reconciliation – for automation of financial reconciliations between company's internal departments or with its counterparties; 2) audit – allowing real time auditing as well as optimizing auditor's involvement in the process; 3) land register – for eliminating the threat of corruption by digitizing an decentralizing a jurisdiction's property deed transfers; and 4) loyalty points – allows for added features and insights for customers by creating a more efficient loyalty points program. [8] • The company claimed that in 2017 it managed in performing its first blockchain audit with all audit standards applied – an accomplishment for its continuous and dedicated efforts to automate some of the auditing processes for its clients. • It launched Blockchain laboratories in New York, Dublin and Hong Kong (Fintech News Hong Kong 2017; Deloitte 2017) with more than 800 experts engaged, seeking for different blockchain solutions.
EY	• The company is involved in the project Libra, focused on distributed ledger technologies and their applications (Allison 2015). • It has developed EY Ops Chain, which has many practical implementations for optimizing accounting work. Primarily, it focuses on areas as payments, invoicing, inventory information, pricing, and digital contract integration (Prisco 2017). • It has developed Blockchain Analyzer, especially designed for auditing of companies that are involved in cryptocurrency transactions. It could be used as a supporting tool for auditing blockchain assets, liabilities, equity, and smart contracts (Thomas 2018).
KPMG	• In cooperation with Microsoft, the company developed the innovative workspace Microsoft Blockchain Nodes, focusing on blockchain application in healthcare and the public sector. Moreover, the use of KPMG Digital Ledger Services is designed to assist companies in providing financial services with expected benefits being efficient automated back-office operations, faster and more secured transactions, reduced costs (KPMG 2017), (Zhang et al. 2020).
PWC	• The company developed the Blockchain Validation Solution, a special audit tool for seeking and detecting indicator patterns for risks that might occur in the long run. • It assists its customers as stock exchanges and digital wallet providers in blockchain applications, including control and implementation of testing standards (Buntinx 2018). • It conducted a profound survey on blockchain applications for the benefit of energy producers and consumers (PWC 2017). • The company sponsored the United Nations's ID2020 event on the future of identity held in June 2017 (Del Castillo 2017).

Source: (Allison 2015), (Bonsón and Bednárová 2019), (Buntinx 2018), (Del Castillo 2017), (Deloitte 2017), (Fintech News Hong Kong 2017), (KPMG 2017), (Prisco 2017), (PWC 2017), (Thomas 2018), (Zhang et al. 2020).

[8]For further readings visit: https://bravenewcoin.com/insights/deloitte-launches-rubix-a-one-stop-blockchain-software-platform

6. REGULATORY CHALLENGES AND IMPLICATIONS

The complexity of the current regulatory landscape is exhaustively researched by Cermeño and well depicted in his seminal work (2016). The author outlines 11 regulatory challenges in respect of distributed ledger (blockchain) technologies. For instance, one of the outstanding issues is related to the possibility for testing distributed ledgers by applying the sandboxes approach. Cermeño (2016, p. 17) defines regulatory sandboxes as a controlled environment for testing innovations with real customers. Companies may first introduce their solutions without taking the whole regulatory burden. In this way new technologies as well as alternative business models could be tested faster and at lower costs in a real-life environment. Sandboxes might alternate the way regulatory authorities provide guidance or propose changes as a response to introduced innovations. Few current regulatory issues are summarized in table 3, accompanied by some brief comments.

Table 3. Regulatory challenges associated with blockchain applications

	Regulatory challenges	Comments
1	Anonymity reduction through KYC[9], AML/CFT[10] Directives.	Some argue that the Fifth Anti-Money Laundering Directive, effective from January 10, 2020, will strengthen the cryptocurrency industry in EU[11]. By putting the cryptocurrency sector in the same legal category as banks, payment processors, games, and gambling-related services, it makes cryptocurrency players equal to any other businesses thus increasing the security in the crypto industry. Potentially, this Directive will impact significantly the European blockchain industry in the years to come. [12]
2	Legal nature of distributed ledgers including territoriality and liability.	Territoriality refers to jurisdiction issues that might arise and the applicable law. Liability is related to responsibility if legal breaches occur. The problem stems from the fact that distributed ledger technologies are not characterized with a specific location. Furthermore, due to the lack of a central authority, nobody could take responsibility for the proper functioning of the ledger and data trustworthiness. Moreover, due to the different national laws, nodes in the network could not be responsible. That is way liability becomes an issue. Hence, a common legal framework that arranges the status of territoriality and liability is required and its development is an urgent issue for the responsible jurisdictions.
3	Recognition of distributed ledgers as immutable tamper-proof sources of truth.	Recognition of blockchains as immutable tamper-proof sources of truth and as a single source of trusted identity is also related to the development of a wide-accepted legal framework that requires as prerequisites harmonized national laws in the areas of data protection and legal person identity.
4	Conciliation of 'Right to be forgotten' and distributed ledgers immutability.	Due to the inherent immutability of blockchain, the kept personal data cannot be deleted thus colliding with the 'right to be forgotten', arranged under EU regulation. This right refers to the personal information of every EU citizen, stored in second party's databases or other electronic or paper records, that should be deleted upon request. Some experts in the field argue that a possible solution to this issue might be the substitution of the right in question with the right to 'impossibility of use'. The latter arranges the use of personal information by third parties and assumes some technical implications.
5	Legal validity of documents stored in a distributed ledger as proof of possession or existence.	Ensuring and monitoring asset ownership on basis of information generated and kept in distributed ledgers is at the heart of this challenge. It is an important issue especially in the use case of asset registers and their management by administration authorities. Its solution requires blockchain to be recognized as immutable source of trust by implementing a proper legal framework of reference that makes the ownership or asset existence unarguable if relevant information is once included in the blockchain.

[9] KYC – Know Your Customer
[10] AML/CFT – Anti-Money Laundering/Combating the Financing of Terrorism
[11] https://www2.deloitte.com/lu/en/pages/risk/articles/amld5-has-entered-into-force.htm.html
[12] https://cryptodnes.bg/nova-direktiva-na-es-she-zadlzhava-bankite-da-rabotyat-s-kripto-predpriyatiya

6	Legal validity of financial instruments issued on a distributed ledger.	Arranging the legal status of financial instruments issued on the blockchain compared to the conventional bonds, derivatives, etc. is an emerging issue. As there might be a whole host of monetary and macroeconomic implications, supervisors and regulators should approach it with caution, especially in certain cases such as native money issue.
7	Real-world enforceability, territoriality, and liability of smart contracts.	These aspects of smart contract being one of the most challenging application of blockchain technologies should be urgently addressed and arranged by a legal framework used as a special frame of reference. As there are many parties involved (the contracting parties, the contract creator and the contract custodian), nobody could take responsibility in case of contract breaches, either caused by malicious behavior or mistakes in coding or defects in contract's design.
8	Treatment of shared information in distributed ledgers from the perspective of cross-border flow of data and data protection.	The legal aspects of cross-border sharing of information and data protection are also current challenges to the policymakers, regulatory and supervisory bodies and should be arranged most probably through some technical solutions. The lack of information privacy is an issue though it is at the heart of distributed ledger technologies. Data access of every participant in the network needs to be properly managed. Another pending problem is the cross-border flow of data that might cause breaches in the existing regulations due to the decentralized nature of the ledger.
9	Use of distributed ledger as a valid ruling register for the internet of things.	A legal framework needs to be developed to arrange territoriality, liability and enforceability issues that might arise in case of blockchain application to the internet of things. Such opportunity is grounded on the shared nature of the distributed ledger and the embedded possibility to store 'identity' of things and information and make transactions between them.
10	Regulatory reporting information standards definition on the blockchain.	One publicly significant application of blockchain technologies is for tracking and monitoring financial activity in real time. It is an opportunity for government and supervising authorities to easily gain an online access to the required information instead of receiving it with a delay. One positive impact is the increased efficiency of the monitoring of the systemic risk of financial institutions. Tackling this issue implies the development of a set of standards arranging the scope of relevant information and the format of data storage.
11	Definition of a regulatory sandboxes approach to test distributed ledgers.	This approach implies several steps to be taken. First, the criteria for a distributed ledger project to enter the sandbox should be worked out. Second, the scale and the limits of the activity performed within the sandbox need to be defined, Third, authorization process assumes certain rules and requirements to be set up. Next, in case of breaching a rule by the tested activities, waivers or modifications should be considered. Further, the sandbox rules need to be aligned with EU and local legislation. Finally, consumer rights should be guaranteed by imposing certain safeguards.

Source: (Cermeño 2016, pp. 12-18).

7. CONCLUDING REMARKS

Distributed ledger technology has the potential to significantly transform the accounting domain, though, it is still in its emerging state of development. It could take decades for the blockchain advances to be fully utilized as key disruptive business technologies and embedded into the accounting ecosystem. There are many potential benefits for both internal and external users of accounting data as reduced reconciliations, increased transparency of transactions, improved quality, and trustworthiness of financial reporting information.

Application of blockchain platforms and tools will facilitate and transform the accounting work. As a result, it will become more efficient and automated. Hence, accounting professionals might concentrate on other job tasks as providing more profound analyses of accounting data, strategic planning, and other consulting services aiming to support the management team. They could give valuable new insights on businesses and improve the investors' decisions. To benefit from the deployment of distributed ledger technologies, the skills profile of the future accountant needs to be expanded with the required blockchain competences and abilities. This is one of the blockchain implications that should be

considered along with other challenges as the demand for relevant legal framework, technology standardization, security concerns and other pending application issues.

Distributed ledger technology is a real challenge to accounting educators as it is their responsibility to well equip accounting graduates with the required technology knowledge and competences in a blockchain-led business environment. Professional accounting organisations as ICAEW have already included blockchain into their qualifications. The timely response of universities implies restructuring of accounting curriculum and enhancing technological content of accounting modules. Interdisciplinary bachelor and master programs will become a priority in the years to come. Comprehensive teaching materials, including case studies, blockchain platforms and accounting systems with embedded blockchain tools for educational purposes need to be developed to help accounting educators and big accountancy firms might support this inevitable educational change by sharing their knowledge and expertise.

ACKNOWLEDGEMENTS

This paper and dissemination of its results is supported in part by Sofia University Science Fund Project 80-10-111/16.04.2020 'Analyzing the effects of new technologies on accounting and accounting education'.

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