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Blockchain – the accounting perspective

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Abstract. *Blockchain remains still an experimental technology, with current applications addressing only some elements of small-scale projects. Once the technology matures however, it has the potential to transform industries and even the economy, as it begins to integrate complementary technologies such as AI and IoT. It has the potential to bring fundamental changes to financial accounting and auditing, and even to entire financial markets. This paper explores the potential for blockchain applications in accounting, identifying major benefits and shortcomings, and analysing opportunities and possible threats. We investigate mainly the organizational challenges raised by an accounting blockchain systems and its potential to enhance the accounting activity. We discuss blockchain's potentially disruptive effect on the accounting profession, and conversely, the potential role of this professions in further developing blockchain technology.*

Keywords: Blockchain, Accounting, Decentralization, Trust, Smart contracts, Security

Introduction

Blockchain is one of the "buzz" word on everyone lips nowadays and the blockchain's technology disruptive effect on potentially each sector of our life is largely recognized, both in academia and industry.

One of the most challenged area is the financial one, with accounting and audit as primarily activities to be dramatically changed in the near future. Apart from the transition from manual to computerized processes, these activities haven't experienced such technology-driven disruption in the past. Blockchain's potential to radically change the accounting, audit and control activities raises therefore a huge interest for professionals in these fields.

While recognized as being one of the most revolutionary technology available today, the theoretical framework for blockchain solutions remains raw and empirical evidence almost insignificant. Blockchain is currently crossing a period of evolving maturity, and most of the researchers focus on its technical aspects. The vast majority of blockchain applications are developed as isolated and particular solutions, and there is virtually no blockchain solution at enterprise level.

The organizational challenges raised by this new technology are somehow left in shadow. However, to reach its full potential, blockchain needs requires decentralization and, therefore, major changes in the way that business leaders understand and accept to run their businesses.

Our research aims to address the blockchain topic mainly from this organizational perspective. This study represents an initial step of a larger research project, with focus on Blockchain in the financial sector. In this phase we intend to explore the theoretical framework for blockchain applications in accounting, discuss organizational and technical challenges, identify benefits and vulnerabilities, and formulate some hypothesis on blockchain solutions and its implications for accounting. Although accounting and audit systems are generally treated

DOI: 10.2478/picbe-2020-0020, pp. 214-224, ISSN 2558-9652| Proceedings of the 14th International Conference on Business Excellence 2020

together in this context, we have chosen to address them separately, as, in our opinion, they require different types of solutions and raise different types of issues from the blockchain perspective.

The rest of this paper is organized as follows. We begin with an overview of blockchain technology and of the current approaches of accounting blockchain as these have been addressed in the literature. In the next section we examine the potential implications of blockchain technology for accounting and the role of accounting professionals in developing blockchain solutions at organizational level. We finish with some conclusions, comments on the limitations of the current study and directions for further investigation.

Methodology

This study represents an initial phase in a broader research project addressing the implications of blockchain technology for the financial sector. In this initial phase, our objective is to investigate blockchain technology from an organizational perspective and to identify its main challenges and opportunities for accounting.

We have chosen as research approach an extensive analysis of both scientific and business literature concerning organizational issues raised by blockchain technology. Such an approach is motivated mainly by the current scarcity of organizational solutions or applications based on blockchain technologies. Without data, any aspect related to blockchain organizational solutions can't be empirically investigated. A qualitative research method would be more appropriate at this stage, and valuable results can be obtained by analyzing opinions of accounting professionals on this subject. This is the next step in our research. The current study aims to clarify different aspects related to challenges, opportunities, advantages, limitations, and possible solutions of blockchain accounting systems, as perceived by both scientific and professional communities.

Literature review

Blockchain – an overview

Undoubtedly, Blockchain represents one of the "hottest" technologies nowadays, with an important potential disruptive effect on our lives. Therefore, is a subject of great interest, both for industry and academia. Being a technology that hasn't reach yet its maturity level, most of the researchers are focusing on its technical aspects. However, Blockchain raises various organizational issues, critical to reaching its full potential. This "organizational perspective" is approached mainly in specific contexts of blockchain applications, while somehow overlooked in the "big picture" of blockchain research.

The origin of Blockchain technology

In 1991, Haber and Stornetta discuss in the article "*How to stamp a digital document*" a technological solution for the problem of time-stamping easily modifiable digital assets in order to track their origin and any attempt to modify them. They propose computationally practical procedures for digital time-stamping of easily modifiable documents, by creating cryptographically secured chain of blocks that makes impossible to back-date or to forward-date a document. These procedures aimed to maintain complete privacy of the documents and, therefore, no record-keeping by a third party was required. The concept of cryptographically secured chain of blocks is considered to be the foundation of blockchain.

The concept of blockchain itself appeared in 2008, when the mysterious Satoshi Nakamoto used it to describe the public transaction ledger for the first digital cryptocurrency (Bitcoin). In the research paper entitled "*A Peer-To-Peer Electronic Cash System*" he described a peer-to-peer system in which people could make instant online transactions directly from sender to receiver without any involvement of any third party like government or financial institutions (Nakamoto, 2008).

Since then, blockchain technology, also referred as "Distributed Ledger Technology (DLT) evolved and has been used in different other platforms.

The concept of blockchain

According to Furlonger and Uzureau, blockchain is "a digital mechanism to create a distributed digital ledger on which 2 or more participants in a peer-to-peer network can exchange information and assets directly without the need for a trusted intermediary" (Furlonger, 2020).

Blockchain technology is a distributed data ledger, in which transactions are recorded in append-only mode and verified through consensus algorithms (Erbguth and Morin, 2016). It is a technological protocol that enables data to be exchanged directly between more participants within a network without the need for intermediaries. Each transaction is codded and added to an unalterable transaction chain, which is distributed to all ledgers (nodes), and thus preventing the alteration of the chain itself. The information relating to each transaction is recorded on a digital ledger, and copies are kept independently by each participant in the network. All the records in the network are unchangeable, time-stamped, encrypted and linked to each other.

Blockchain technology combines existing technologies into an innovative architecture defined by five elements (Furlonger, 2020):

-*Distribution.* Participants are connected on a network, each of them operating a full node and maintaining a complete copy of the ledger, which updates with new transactions as they happen. Each node (the machines used by participants) is set to run the consensus algorithm. Although any participant can review any part of the ledger, it cannot change it in the absence of given circumstances.

-*Encryption.* Special technologies, such as public and private keys, are used to record data securely and privately in the network, so the participants can control the information shared (including their personal identity) in a transaction. It is however important to note that, even the participants are semi - anonymous (they have pseudonyms) the blockchain authenticates each participant and validates the ownership of the assets to be transacted.

-*Immutability.* Once completed, transactions are cryptographically signed, time-stamped and sequentially added to the ledger. Once recorded, transactions can be changed only with the agreement of all the participants.

-*Tokenization.* The value exchanged in the blockchain comes in the form of tokens, as a way to secure this process in a digital environment. Tokens might function as digital representations of physical assets, as a reward mechanism to incentivize network participants, or to enable the creation and exchange of new forms of value.

-*Decentralization.* As both the information in the network and the operating rules of the network are kept by multiple nodes, there is no single entity that has a central control over it. Transactions are verified and approved through a consensus mechanism operated on each node. This consensus-driven structure removes the need of a central authority to establish trust, identity and payment and acts like a shield against fraud and corrupted transactions.

It is extremely important to note that only *together* all these components create a transparent and trusted environment in which to create and share value. However, most of the developed or currently developing blockchain solutions use only some of these components.

Blockchain - the value for business

Businesses' interest in blockchain technology is mainly related to its potential to deal with new types of assets. We live in a world where IoT sensors, mobile devices and other enabling devices are capable to constantly generate huge amounts of data, which can be captured in network environments. In other words, both new digital and physical assets are imprisonable in a network structure. Cryptocurrencies, units of data, reward points or simply pieces of an asset are new forms of value tradable in single units in a digital market. These assets can't be monetized and transacted by the existing centralized infrastructure businesses rely on, which hasn't been designed to handle machine-to-machine transactions of digitalized or digital assets. Only a decentralized mechanism that brings trust and transparency for all the participants can handle securely and efficiently a vast number of micro-transactions in a distributed machine-centric environment. Therefore, blockchain represents a reliable solution that allows interactions on the digital market to unearth the value of new digital assets.

Additionally, blockchain can redirect existing value flows, by reducing control over four business currencies (data, access, technology and contracts) by central powers (digital platforms, large multinational corporations, large intermediaries) and reopening existing markets to new competition.

Future of blockchain

Despite its potential to create new value and unlock existing value flows, blockchain remains still an experimental technology, with current applications addressing only some elements of small-scale projects. The attitudes towards blockchain followed the common pattern faced by young and evolving technologies - they moved from a "hype" characterized by unrealistic expectations to real disappointments brought by the cryptocurrency crash in 2018. Currently, blockchain crosses a period of "evolving maturity", focused on enabling technologies for two of its defining components: distribution and encryption.

According to Gartner, blockchain will evolve through three phases in the next ten years, with a first step focused on *operational improvement* followed by a second one dedicated to the "*real business of blockchain*" – reengineer business relationships and redistribute existing data and value flows in ways that could reinvent how business engage in a digital world (Panetta, 2019).

A first phase began after 2012 and is expected to last through the early 2020's. This is the phase of *Blockchain-inspired solutions*, in which only three of the five elements of blockchain are used: distribution, encryption and immutability (Zheng et. al, 2017).

In this period of evolving maturity, blockchain is confronted with both technical and organizational challenges. If the technical challenges are expected to be solved by 2025, the organizational ones are more resilient. One of the core elements of a fully developed blockchain solution is decentralization, which means that business leaders must accept full transparency and be comfortable with automated business decisions outside their full control. This is very difficult. Moreover, the main intermediaries of the existing centralized infrastructure (market intermediaries, technology infrastructure providers) are constantly pouring more suspicions in

their clients' ears (Furlonger & Uzureau, 2020). Since all the blockchain-inspired solutions are designed in a centralized environment, they don't allow unmediated trade of digital assets.

The second phase is expected to start in early 2020's and to last until 2030. In this phase, called *Blockchain complete* all the 5 elements (distribution, encryption, immutability, tokenization and decentralization) are used. The major difference from blockchain inspired solutions is the presence of tokens operating in a decentralized environment using smart contracts.

The third phase, expected to start after 2030, is characterized by the integration of complementary technologies within blockchain networks. Technologies like Internet of Things (IoT), Artificial Intelligence (AI), Self-Sovereign Identity (SSI) will expand the value that can be monetized and exchanged in the network, allowing more smaller transactions supported by smart contracts to take place. This *Enhanced Blockchain* has the potential to generate new business models based on decentralized operational structure, with completely autonomous transactions. Every category of human endeavors, be it in education, economy, politics, healthcare or science could be reinvented. Blockchain is proving to be the fifth disruptive computing paradigm shift (Mutambaie, 2018).

Accounting and audit – current approaches to the blockchain challenge

Blockchain feats accounting perfectly, while it can be considered its specific technology. According to Swan blockchain is like a giant spreadsheet for registering all assets and an accounting system for transacting them on a global scale (Swan, 2015). Certainly, this technology will generate an important revolution in the way documents and ledgers will be generated, controlled, archived and updated. An "universal entry bookkeeping' system shall emerge. The key features of the blockchain are redesigning the accounting information system through: a) universal propagation: all participants have identical copies of the ledger, no one controls it and there is a rapid propagation of new entries within the system ; b) immutability> no possibility to change it without consensus; c) programmability: throughout smart contracts (ICAEW's IT Faculty, 2018).

In 2019 Deloitte conducted a survey to assess the perceptions of 1384 senior executives from countries worldwide about the impact of the blockchain technology (BT) in the future, in companies with more than US $100mil in annual revenues. Another subsequent survey was then conducted on managers of 13 blockchain emerging disruptors and investment in the sector to search for the technology issues. The first important finding was that there is already a shift from "blockchain tourism" to a more material development, specifically in the fintech domain. 53% of respondents stated that blockchain becomes a critical milestone of their business, 10% higher than in 2018. Additionally, the attitude towards this subject was improved, 86% viewing the possibility of mainstream adoption, blockchain considered scalable. Barriers to greater investment in blockchain were perceived lower in 2019, as compared to 2018. One of the final conclusions was that "…executives …should ask (about) the role blockchain can play within their organizations" (Linda Pawczuk, Deloitte Consulting Leader for blockchain and cryptocurrency).

This survey is also providing a regional analysis, on China, Singapore, Israel, US. China established blockchain as top-five critical priority, emphasizing areas where blockchain could generate specific applications (i.e. product traceability, copyright protection). Singapore

considers blockchain as fundamental to the economy and promotes cryptocurrency, the government being very supportive on free public blockchain platforms; additionally, favorable tax treatment and public funding for blockchain development were enforced. Israel is a leader the crypto revolution, in digital assets implementation, focused mainly on cryptography's R&D; Stock Exchange is developing blockchain applications and governmental agencies start adopting blockchain, in their communications. The USA Government becomes a blockchain user and regulator; regulations on the legal status of cryptocurrencies have evolved, data protection limits how the personal information may be handled, in some states laws to enforce blockchain transactions were proclaimed (Deloitte, 2019).

The accounting profession is facing an important challenge today, in leading the blockchain development and implementation. The profession contribution should be valuable not only in developing specific, effective regulations and standards but also in advising companies and other stakeholders when dealing with blockchain and cryptocurrency and optimizing their processes and systems. New skills will be needed, specifically on technology, consulting and providing value-added to clients. Additionally, the ability to act as an arbitration party in between technical people and business stakeholders could be considered an important new skill to be acquired.

Although measuring rights and obligations from transactions might concern accountants in connection to blockchain, this technology may help the enhancement of the financial profession, by uplifting the main efforts from bookkeeping to more value-added subjects, such as: planning and valuation, integrated analysis and complex interpretation of various outcomes, data systems assessment. More transparency and timeliness information will become also attributes that professionals will have to integrate in their wok.

Other important implications will concern the external auditors. Data, information and procedures confirmation won't be necessary anymore, the transaction level assertion will change, specific substantial procedures will evolve towards a more holistic, business integration approach. Most of the auditors' specific procedures were repetitive, involving a great amount of manual work on reframing and checking the information "true and fair "impact on financial statements, in other words to assess whether the bookkeeping system in free from material errors and biases. Samples were generated and material levels were assumed within these specific endeavors. Most of these procedures and techniques will disappear or radically change, replaced by blockchain and machine learning facilities, leaving more time and space for other value-added contributions.

On the other hand, transactions within a blockchain system should still be assessed in terms of their authorization and "according to regulations" features, whether related parties had been involved, correct classification, measurement and disclosure to financial statements. Procedures on management's estimations, possible fraudulent transactions, blockchain protocol should be performed in the future as well, as the most important part of the auditors' endeavor. Automate on-going alerts will help increase the efficiency and the saving time can be devoted to more high-quality areas of audit.

Blockchain makes useless the service of a central authority. Being a peer-to-peer network, transactions are recorded securely in blocks and organizations will not have to keep backups in forms of physical and digital records. This requires a new framework and specific regulations, and countries and organizations are preparing for these challenges. In 2019 the regulation framework of blockchain and crypto currencies has been significantly changed all over the world.

The EU new Directive on money laundry was preceded by UK's Financial Court of Authority instructions on cryptocurrency assets related businesses. This edict regulates entities that issue, store and/or provide marketing of products and services in this domain. Stricter rules are enforced in connection to identification of the owners of these products and services, specific investments and trading in the area. In US new regulations concerning the subject were introduced by the Congress last year, emphasizing how business models can be affected and how authorities may use distributed ledgers in their activity. Nevertheless, cryptocurrencies are excluded from the securities laws. US New blockchain framework was provided in Switzerland by the Swiss Financial Market Supervisory Authority (FINMA) and framework for Initial Coin Offerings (ICOs) and Digital Assets Service Providers (DASP) was enforced in France, last year (Deloitte, 2019).

Blockchain accounting

With its main objective of transferring the ownership of assets while assuring a ledger of accurate financial information in a secure and trusted environment, blockchain is, undoubtedly, an accounting technology. Therefore, blockchain is expected to change the present accounting system in different ways. While both researchers and accounting professionals agree on the disruptive potential of blockchain technology for accounting, it is still unclear how these transformations will occur, what challenges and risks will bring along the process and how it will impact the accounting profession.

All these issues are replicated also for the audit system and audit profession. Although in many studies concerned with blockchain disruptive effect accounting and audit are approached as one system, this study explores it only for the accounting system. We consider that, although related, accounting and audit systems present particularities that will differentiate the potential impact of blockchain upon them.

The potential of blockchain for accounting

Blockchain creates an innovative method to catalogue and account for data. Shared recordkeeping, a distinctive feature of the blockchain, allows the "trust" element in various relationships to be determined by consensus versus promise. (McComb & Smalt, 2018)

Blockchain offers transparency and certainty over ownership and history of assets and existence of obligations. This will free much of the accountants' time and reduce the costs of maintaining and reconciling registers, which will greatly improve efficiency. Moreover, with recordkeeping transferred to the blockchain, more resources will be available for planning and valuation.

New types of assets, which are very difficult to measure in a traditional accounting system, can be managed by blockchain accounting. With the technology evolving to enhanced blockchain solutions, transactions of digital or digitalized assets will be automatically recorded in cryptographically protected blocks. The blockchain could also make settlements on maturity of different assets based on smart contracts and record them. This *real time blockchain accounting* is considered in the present as being the future of accounting systems.

Advantages, challenges, risks and opportunities of blockchain accounting

Blockchain promises to offer many benefits to the accounting system, by automating the process of recording and keeping transactions on digital assets in a secure and trustful environment. Some of the most appealing ones are (Sarkar, 2018; Zhiwei et al,2018; McComb & Smalt, 2018):

-*Improved efficiency.* Records are kept only once, in blocks accessible anytime by any authorized user. This will reduce the cost of maintaining physical or digital records. Also, with transactions recorded in real time and ledgers instantly updated, reconciliations will be removed from the recording process. The modern technologies, like Artificial Intelligence and Data Analytics will optimize many accounting processes in an enhanced blockchain system. All these will increase efficiency and value of the accounting function.

-*Authenticity of information and reduction in fraud.* Unlike physical or digital records, blocks in a blockchain are not susceptible to unauthorized alterations. This will ensure the accuracy of information stored in the blockchain and will dramatically reduce the chance of fraud. Within a real time blockchain accounting, the risk of any errors will be completely eliminated.

-*Real time reporting.* In a real time blockchain accounting, any user registered in the network or external regulator will be able to access information about an organization in real time.

-*Focus on value-added activities.* All the organizations' resources involved in the traditional record keeping will be available to other value adding activities of the organization in blockchain accounting.

All these potential benefits of blockchain accounting are promising but in the same time are raising concerns for the accounting system. Being a solution based on "undoubtable" trust assured by line codes and machines, it is still difficult to be fully embraced by a system in which trust is built throughout human validation and enforced by strict regulations. Blockchain is a technology that redefines trust in the new generation systems (Sachs, 2018).

Moreover, there are technical and organizational challenges attached both to the process of transformation from traditional accounting systems to blockchain accounting systems and to the latter one itself.

One of the main challenges is related to the infrastructure for blockchain (Zheng et al, 2018). As blockchain is highly dependent on Internet, the risk of an improper infrastructure must be seriously considered. In this context, a high level of cybersecurity is required.

Another challenge is related to the fact that accounting is largely dependent on regulations. Although the blockchain technology can assure that these regulations are properly respected, it should be flexible enough to allow the adoption of any new regulation or the adjustment of existing ones on real time basis.

The scale to which blockchain is adopted by organizations represents another challenge for the accounting blockchain. In order to be effective, blockchain accounting needs to be adopted by a sufficiently large number of organizations (Inghirami, 2018). Currently, enterprise blockchain solutions are still in their infancy and the number of organizations that attempted experimenting with blockchain in accounting is rather small.

Implications for the Accounting profession

Certainly, blockchain will change the accounting profession itself – the accountant work will migrate from bookkeeping and reconciliation to other value-adding activities in judgmental area and advice. Although measuring rights and obligations from transactions might concern accountants in connection to blockchain, this technology may help the enhancement of the financial profession, by uplifting the main efforts from bookkeeping to more value-added subjects, such as: planning and valuation, integrated analysis and complex interpretation of various outcomes, data systems assessment. Accountants will need to assess the real economic interpretation of blockchain records, by matching those to economic reality and valuation.

Another important aspect is related to the role that accounting is authorized to play in the development and adoption of blockchain technology itself. Accountants are experts in all the domains imbedded in blockchain model: *standards setting, business logic, record keeping, application of complex rules* (Smith, 2018). Therefore, they should be involved in the "business" design of different blockchain solutions, together with those who have technical knowledge of how blockchain works. Accountants have the opportunity to act as consultants to organizations considering blockchain solutions. They should play the bridging role between technologists and business stakeholders in the process of blockchain adoption and also advise on the impact of blockchain on their businesses and clients.

Conclusion

In this paper, we present a comprehensive overview on blockchain and its potential to enhance the accounting activity. Our research has shown that this topic is still immature. Blockchain is one of the most revolutionary technologies available today but unlocking its true potential require more than technical improvements. While issues like scalability, latency, privacy, security or authentications are largely recognized as being significant obstacles on blockchain maturing path, organizational and human issues remain still in a shadow. However, these are critical to implementing a blockchain solution at organizational level.

As theoretical applications transition to successful proof of concept successes blockchain technology will become an integral part of the information technology ecosystem. Undoubtedly, it will have a tremendous impact on financial sector, with one of the most challenged areas being financial accounting. Blockchain has the potential to largely increase the accounting information and to reduce the errors in disclosure and earnings management. Moreover, the role of financial accountants will change. They will be no more expected to record transactions and make financial statements, but to validate both the source documents and the reasonability of smart contracts used in accounting blockchain.

This potential impact is generally recognized and intensely studied by accounting and audit professional bodies. However, it seems that for a largely part of accountants blockchain is still a rather "exotic" technology related mostly to cryptocurrencies. Therefore, they not only undermine their chances to take full advantages of blockchain accounting, but also miss the unique opportunity to participate in the process of designing blockchain solutions for their clients.

These results outline the framework for a future research, aiming to explore the accounting professionals' attitudes and approaches towards blockchain and its impact on accounting system.

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