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A literature review on blockchain in accounting research

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Abstract

This study aims to review the academic literature on the utilization of blockchain in accounting practice and research to define potential opportunities for further scientific investigation and to provide a framework on how accounting practice has been or will be impacted by blockchain. This study is based on a systematic literature review of 234 research products available on Scopus, which were mapped through bibliometric analyses and critically discussed through five main topics related to the impact of blockchain on accounting, auditing, crypto assets, supply management, and finance. Blockchain has many potential implications for accounting practice and research. Accountants and auditors are interested in triple-entry bookkeeping and the inalterability of blockchains. Accountant and auditor roles might change, focusing more on non-automated activities. However, blockchain could also play a more central role in social and environmental accounting and reporting because there are fewer confidentiality issues than financial data. The problem of the representation of cryptocurrencies in the financial statements following the IFRS interpretations commission can be considered clarified, but significant audit and taxation issues remain. Moreover, blockchain technology holds potentialities for innovating business models in many diverse sectors. The novel contribution of this study is threefold. First, this SLR provides a clear picture of the state of accounting research on blockchain. Second, it provides an investigation of how accounting practice will be impacted by blockchain. Third, it contributes to the accounting literature with a discussion of the potential future research trends in blockchain for accounting.

JEL Classifications: M40, M41, M42

Keywords: Blockchain; Cryptoassets; Triple-entry bookkeeping; real-time accounting; continuous auditing.

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1. Introduction

New technologies and digital innovations are gradually reshaping the contours of accounting, auditing, and reporting (Bonsón and Bednárová, 2019; Dai and Vasarhelyi, 2017; Lombardi and Secundo, 2020; Marrone and Hazelton, 2019). In the last twenty years, a multitude of academic studies focused on the implications for accountancy research and practice of new technological paradigms such as automation (Kokina and Davenport, 2017a; Susskind and Susskind, 2015), big data (Cockcroft and Russell, 2018; Gepp *et al.*, 2018; Vasarhelyi *et al.*, 2015), cloud computing (Choudhary and Vithayathil, 2013; Cleary and Quinn, 2016), social media (Arnaboldi *et al.*, 2017; Manetti and Bellucci, 2016; Ramassa and Di Fabio, 2016; Unerman and Bennett, 2004) and artificial intelligence (Issa *et al.*, 2016; Moșteanu and Faccia, 2020; Sutton *et al.*, 2016; Wilson and Sharda, 1994). Among emerging technologies able to revolutionize business models and consequently change the processes underneath management control, accounting, auditing and reporting is blockchain (Schmitz and Leoni, 2019). Blockchain is a distributed digital ledger shared by several peers in a network that facilitates recording transactions and tracking the property of tangible and intangible assets. Any transaction in the network is recorded, certified, and saved in a database (JPMorgan Chase, 2021). Transactions are communicated to all network participants, which maintain and collectively validate identical ledger copies, creating an unalterable transaction register. Approved transactions take the shape of blocks added to a chronological chain of previously validated blocks using a cryptographic signature (Bonsón and Bednárová, 2019). Each new block is marked chronologically and contains information that refers to the block that preceded it, ensuring that any attempt to adulterate the blockchain would require adulterating each block previously created, something almost impossible given the decentralized ledger (Bonsón and Bednárová, 2019; Buterin, 2014).

Although the popularity of blockchain is usually linked to being the foundation of Bitcoin and other crypto-assets (Buterin, 2014; Nakamoto; 2008), the public and institutional attention is now extending to the technology itself and its potentially disruptive applications to other than digital currencies. Such applications include decentralized finance (De-Fi) (Chen and Bellavitis, 2020), non-fungible tokens (NFTs) (Regner *et al.*, 2019) and, most notably, smart contracts (Buterin, 2014; Cong and He, 2019; Hughes *et al.*, 2019; Rozario and Vasarhelyi, 2018), systems which automatically control the property of digital assets according to arbitrary pre-specified rules (Buterin, 2014).

Many experts go so far as to say that the spread of blockchain-based decentralized applications can have the same disruptive impact as the advent of the Internet (JPMorgan Chase, 2021; Schmitz and Leoni, 2019; Yermack, 2019; Suyambu, 2020). Although this impact is complicated to predict, recent reports elaborated by the Big Four audit firms (Deloitte, 2016,2020; KPMG, 2018a,b; PwC,

2020; EY 2020) suggest that accountants, auditors and regulators will be significantly affected by blockchain innovations, especially with regards to processes connected with the way transactions are initiated, processed, recorded, reconciled, audited and reported (Coyne and McMickle 2017; Ferri *et al.*, 2020; Schmitz and Leoni, 2019).

Despite the mounting discussion on the potential of this technology for business (Coyne and McMickle, 2017; Dai and Vasarhelyi, 2017; Kokina *et al.*, 2017b; Schmitz and Leoni, 2019; Yermack, 2019), research on blockchain in the field of accounting remains sparse and unsystematized. The implications of blockchain technology and its applications are still an emerging research strand that is under-investigated in accounting, auditing, and reporting. We believe it is urgent to fill this gap with insights on the potential and challenges of blockchain technologies in accounting practice and research.

Against this background, the present study is timely as it intends to review the literature on the utilization of blockchain in accounting practice and research and define potential opportunities for further investigation. Despite other literature reviews on the implications of blockchain in accounting and auditing (Schmitz and Leoni, 2019; Bonsón and Bednárová, 2019; Secinaro *et al.*, 2021), to our knowledge, this is one of the very first studies specifically resorting to a mix of systematic literature review (SLR) and bibliometric analyses that encompasses a multidisciplinary and comprehensive perspective and include a vast amount of research products (books and recent conference proceedings included) on accounting, auditing and reporting.

The contribution of this study is threefold. First, this SLR provides a clear picture of the state of accounting research on blockchain. Academics and practitioners have a growing but still limited engagement with blockchain potentials and technological advancements (Schmitz and Leoni, 2019). However, if accountants and auditors want to be on top of blockchain diffusion and corporate adoption, such limitations need to be overcome promptly. At this crucial moment for the distribution and development of blockchain technology - when large companies, institutions and big audit firms already became convinced adopters (EY, 2020; PwC 2020) - our study provides an up-to-date, comprehensive SLR of 234 research products indexed on Scopus on the link between blockchain and accounting.

Second, this study provides an investigation of how accounting practice will be impacted by blockchain. Our discussion of the main contributions on the link between blockchain, accounting, auditing, cryptoassets, supply management, and finance can support current and future accountants and auditors in approaching fast-moving blockchain development. Blockchain has the potential to improve information timelines and accounting reliability because of decentralization and transparency (Bonsón and Bednárová, 2019), but it will also require new competencies, attention to

scalability and reconciliation in accounting standards. Against this background, this is one of the first studies to provide an SLR of blockchain research in the accounting and auditing context to offer an overview of blockchain disruptive innovation to both academics and practitioners and policymakers and regulators.

Third, our study contributes to the accounting literature with a discussion of the potential future research trends in blockchain for accounting. We believe this study will be a helpful resource for present and future scholars interested in tackling the most meaningful connections between accounting and the disruptive applications based on blockchain, such as accounting for decentralized crypto-assets, continuous reporting and auditing, autonomous supply chain management and evaluation, reduced transaction costs due to smart contracts.

The present article is structured as follows. After this introduction, the second section presents the details of our methodology for the SLR using PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) and introduces a set of bibliometric visualizations of the 234 included research products. The third section discusses the primary and most impactful contributions on the link between blockchain, accounting and auditing. In particular, Section 3.1 addresses the historical, conceptual and applied aspects of blockchain for accounting and auditing; Section 3.2 discusses the challenges of accounting for crypto-assets; Section 3.3 summarizes the main contributions that address the accounting implications of blockchain technology from a financial perspective; Section 3.4 tackles the implication of blockchain for management and business model innovation; Section 3.5 analyzes the potential of blockchain for supply chain management. Finally, the concluding section pulls the strings of our threefold contribution and provides an agenda for future impactful research on blockchain for accounting and auditing.

2. Methodology

This study adopts a systematic approach to literature review to minimize bias and give our results scientific value. To ensure the robustness of our protocol, we built on other literature reviews in accounting (Bartolacci *et al.*, 2020; Fragoso *et al.*, 2020; Lombardi and Secundo, 2020; Massaro *et al.*, 2016; Tarquinio and Posadas, 2020) and follow the Denyer and Tranfield (2009) principles: transparency, inclusivity, explanatory, heuristic. Finally, we checked the presentation of the steps of our analysis using the PRISMA Statement (Page *et al.*, 2021a, b), which assists authors in improving the reporting of systematic reviews.

2.1 Design the plan

A critical factor that makes a systematic review auditable and replicable is its clear and explicit protocol. In this research, we adopt the Jesson *et al.* (2011, p. 12) protocol which prescribes the following steps: 1) Define the research question, 2) Design the plan; 3) Search for literature; 4) Apply exclusion and inclusion criteria; 5) Apply quality assessment; 6) Discussion. This also influences the sub-structure of this section in which we declare every decision we have made step by step, which is our way to pursue the transparency principle needed for a systematic review.

2.2 Define the research question

A systematic review process is led by its research questions that define the subject, the object, and the research scope (Booth *et al.*, 2012). Accordingly, we identified the following research questions:

RQ1. What is the academic state of the art of research on blockchain for accounting?

RQ2. How will blockchain change accounting and business practices?

RQ3. What are the future research trends in blockchain for accounting?

RQ1 and RQ3 explicit common goals of the systematic review process (Massaro *et al.*, 2016) about research, while RQ2 clarifies our intention also to investigate practical and managerial implications. As explained before, some characteristics make blockchain technology attractive from an accounting perspective.

2.3 Search for literature

We selected Scopus as our primary source of information to assure both scientific robustness and inclusivity. Scopus is one of the most comprehensive and widespread electronic index databases that allows us to do complex research within scientific production. Thus, building on the considerations illustrated in the introduction, we identified a preliminary set of keywords related to our topic: blockchain, cryptocurrencies or crypto-assets (crypto*), accounting, accountability, accountant (account*), auditing, auditor, audit (audit*), reporting, report (report*).

Because we are interested in academic production and we want to comply with the inclusivity principle, we have selected the following source types: article, conference paper, book chapter, and book. Furthermore, we included only papers that belong to the “Business, Management and Accounting” area to exclude many non-relevant papers. We excluded articles written in a different language than English to avoid comprehension issues and improve the research’s replicability for the

international community. Since this is one of the first literature reviews in this field, no time filter was applied.

Finally, the research string has been validated through an online survey administered to five experts in the field of accounting, law, and the technical aspects of blockchain and two experts in the area of systematic literature review in the field of business and management. This group of experts rated the most significant keywords to be included in the research string and suggested variations that refined the perimeter of our literature review.

Against this preparatory background, our Scopus research string is thus defined as:

(TITLE-ABS-KEY (blockchain OR crypto*)) AND (TITLE-ABS-KEY (account* OR audit* OR report*)) AND (LIMIT-TO (SUBJAREA , "BUSI")) AND (LIMIT-TO (DOCTYPE , "ar") OR LIMIT-TO (DOCTYPE , "cp") OR LIMIT-TO (DOCTYPE , "ch") OR LIMIT-TO (DOCTYPE , "bk")) AND (LIMIT-TO (LANGUAGE , "English"))

We extracted data from the database on 20 April 2021. 502 documents were retrieved. 3 of them were duplicated items, so the final number of retrieved documents was 499.

2.4 Apply exclusion and inclusion criteria

This phase aims to refine our literature perimeter and select only relevant articles to answer our research questions. To choose the articles to exclude because not relevant, we have manually analyzed the title, the abstract, the keywords and, if needed, the full text (Booth *et al.*, 2012, p. 99). To execute this task, we clustered the articles into the categories shown in the table below, and we excluded those not pertinent to our research questions which were erratically captured by our research string.

Table 1 - Research products distribution by topics

Topics	Total N.	First year of publ.	Latter year of publ.	Included
Accounting & Auditing	87	1980	2021	Yes
Cryptoassets Accounting	11	2018	2020	Yes
Finance	54	2000	2021	Yes
Management	42	2004	2021	Yes

Supply Chain	40	2008	2021	Yes
<i>Industrial Engineering</i>	42	2006	2021	<i>No</i>
<i>Information technology (IT) & computer science</i>	170	1996	2021	<i>No</i>
<i>Law</i>	31	1991	2020	<i>No</i>
<i>Medical & Physics</i>	4	2004	2016	<i>No</i>
<i>Political Science</i>	18	2008	2021	<i>No</i>
Total	499	1980	2021	

At the end of this process, 234 articles were considered relevant on the basis that the content analysis has confirmed the link with our research questions

Figure 1 - Research products distribution over time

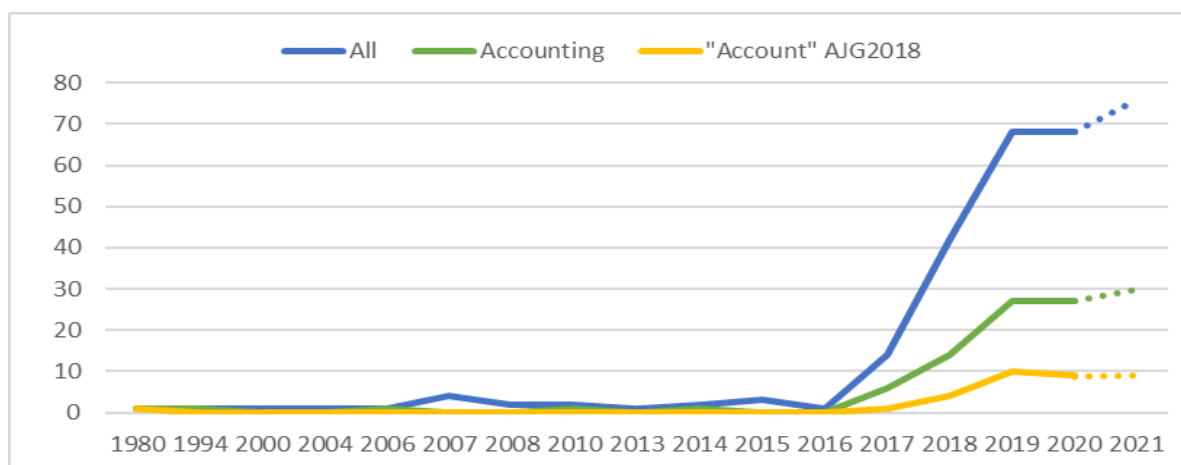


Figure 1 show the distribution over time of the included research products. The blue line includes all the 234 research products assessed for discussion. The green line represents all the 87 research products that we have classified as related to the “Accounting & Auditing” topic. The yellow line focus on articles published in journals ranked as “ACCOUNT” in the AJG2018 journal ranking by ABS.

The above image shows a considerable interest increase since 2016, which is also the same year that accountants and practitioners started to heavily consider blockchain as a tool in accounting (Kokina et al. 2017b). This result is in line with the history of this technology (Buterin, 2014; Dai and Vasarhelyi, 2017).

Table 2 - Main Journals

N.	Journal	Research products	ABS AJG2018 SECTOR	ABS AJG2018 RANK	CiteScore 2020	SJR 2020	SNIP 2020
1	Journal of Emerging Technologies in Accounting	10	INFO MAN	1	3.5	0.756	1.648
2	Australian Accounting Review	5	ACCOUNT	2	3.5	0.551	0.990
3	Accounting Perspectives	5	-	-	1.0	0.238	0.840
4	International Journal of Accounting Information Systems	5	ACCOUNT	2	6.4	0.897	2.513
5	Managerial Finance	4	FINANCE	1	1.5	0.271	0.656
6	Quality - Access to Success	4	-	-	1.6	0.210	0.434
7	International Journal of Digital Accounting Research	4	-	-	2.8	0.288	0.866
8	Academy of Accounting and Financial Studies Journal	4	-	-	1.4	0.200	0.661
9	Technological Forecasting and Social Change	4	INNOV	3	12.1	2.226	3.037
10	Journal of Information Systems	3	ACCOUNT	1	4.1	0.859	1.654
11	Current Issues in Auditing	3	ACCOUNT	2	0.7	0.274	0.581
12	Intelligent Systems in Accounting, Finance and Management	3	FINANCE	1	6.4	0.846	1.540
13	Meditari Accountancy Research	3	ACCOUNT	1	5.2	0.659	1.072
14	Journal of Payments Strategy and Systems	2	-	-	0.5	0.219	0.276
15	Information Society	2	INFO MAN	3	4.8	1.133	1.638

Table 2 displays the leading journals that have published articles included in this review. Linking these data to the positive trend shown in Table 1 could suggest that the topic can become mainstream in the following years. This confirms the opportunity to recap what was already studied and move a step further.

2.5 Apply quality assessment

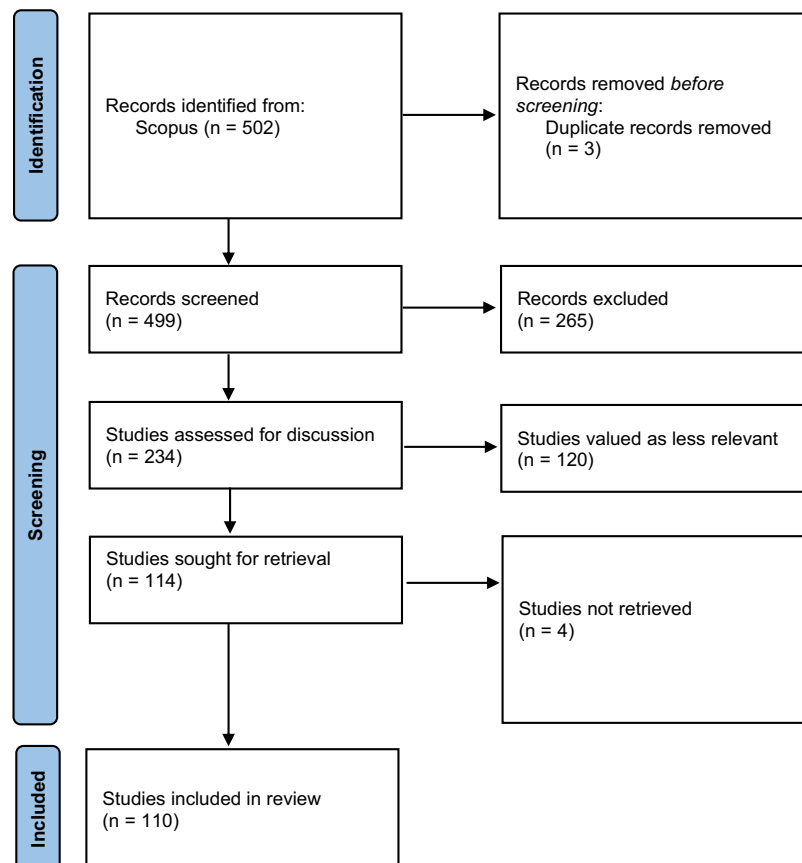
We decided not to apply any quality exclusion criteria a priori. This choice is justified to assure inclusivity (Denyer and Tranfield, 2009). Consequently, we opted not to exclude those papers that were published in journals with moderate to low impact factors. Moreover, being blockchain for

accounting a recent topic, we decided to include conference papers and book chapters. However, we did a quality assessment during the discussion when we dedicated more attention to articles with higher citations per year and published in journals with a higher impact factor, as they have more opportunities to influence the academic and business community.

2.6 PRISMA diagram

We represent our steps through the PRISMA diagram (Page *et al.*, 2021a, b) adjusted by us to enhance the fitting for qualitative systematic review.

Figure 2 - PRISMA flow diagram



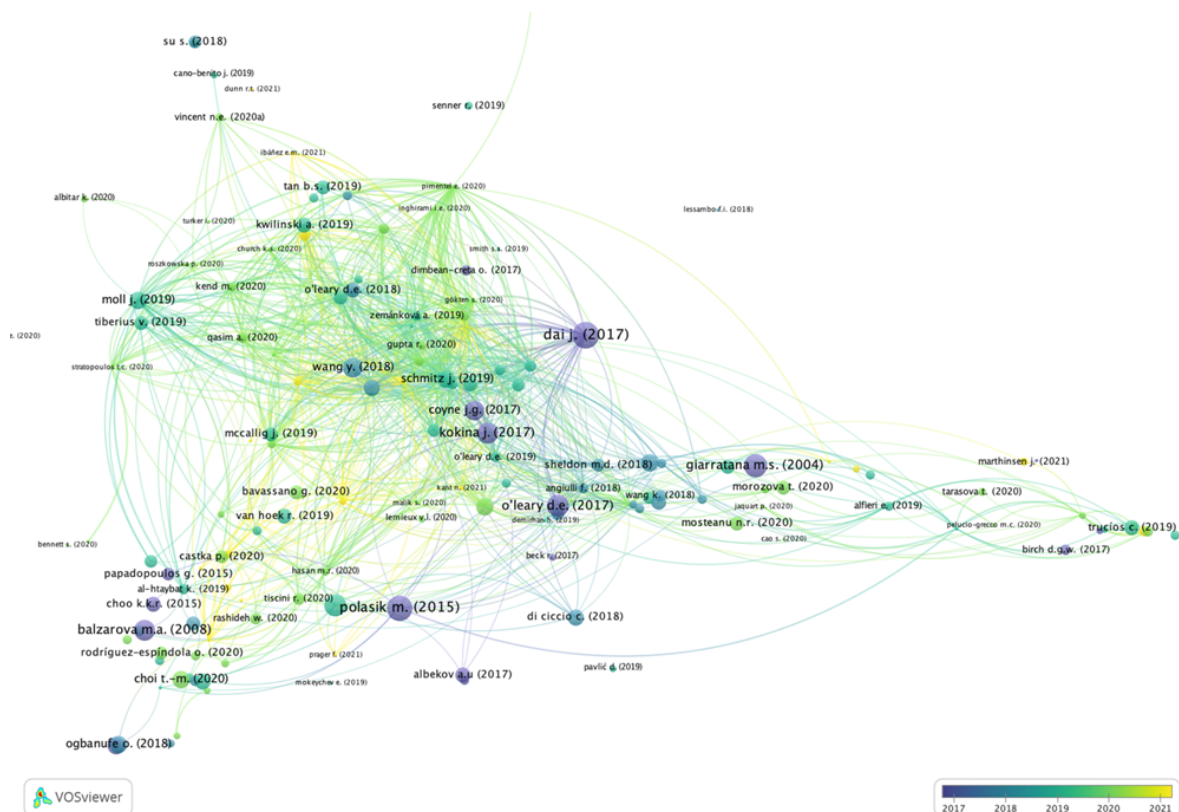
2.7 Bibliometric mapping/visualization

Considering the number of contributions identified, we also ran a bibliometric analysis using the tool of bibliographic coupling. Visualization has proven to be a powerful approach to the analysis of a

large variety of bibliometric networks, ranging from networks of citation relationships between publications or journals to networks of coauthorship relationships between researchers or networks of cooccurrence relationships between keywords (Van Eck and Waltman, 2014).

Figure 3 provides a visualization of the bibliographic sub-network composed of the largest set of connected research products (164) included in our analysis. This network analysis is built on the correspondences in terms of the cited literature. The analysis of the citations of the research products was conducted through the method of bibliographic coupling using VOSviewer 1.6.16 software. Bibliographic coupling measures the similarity between two publications by identifying the number of references they share. Practically, two publications are bibliographically coupled if a third publication is cited by both publications. When the number of references two publications have in common is larger, the bibliographic coupling relation between the publications is stronger (Van Eck and Waltman, 2014).

Figure 3 - Bibliometric network of the included products with year-of-publication overlay

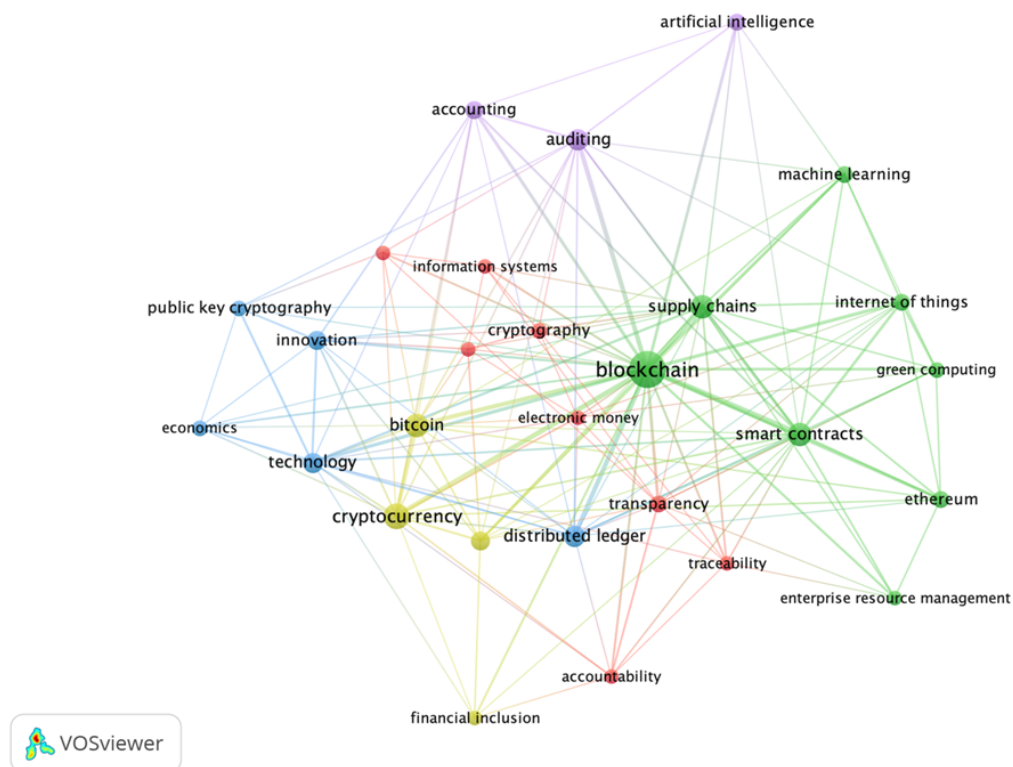


The list of references for each research product was collected on SCOPUS. To compute this strength value, we used VOSviewer’s full counting methodology, as recommended by Van Eck and

Waltman (2014). In Figure 3, overlay colors support a visualization based on the year of publication. The overlay is useful to highlight the development of accounting and business research on accounting from 2017 (purple) to 2021 (yellow). The sizes of the dots associated with each node are weights defined by the number of citations of each publication. This approach is useful in highlighting the seminal, most-cited publications. The thickness of the links represents the strength of the bibliographic coupling between associated publications based on the number of common references.

Figure 4 provides a visual representation of the cooccurrence analysis. In a cooccurrence analysis of keywords, the relatedness of the items is determined based on the number of documents in which keywords occur together. For other terms, the topics addressed in included research products are aggregated by relevance based on the 'authors' keywords. This analysis included the 'authors' keywords that occurred in a minimum of 5 publications. For data cleaning, a thesaurus file has been used to merge similar keywords (e.g., audit and auditing, cryptocurrencies and cryptocurrency, etc.).

Figure 4 - Cooccurrence analysis of the authors' keywords



In Figure 4, the keywords are grouped into clusters, which are a set of closely related nodes included in a bibliometric network. The clusters do not overlap in VOSviewer, meaning that the items may belong only to one cluster. In this form of visualization of a bibliometric network, VOSviewer uses colors to indicate the cluster to which a node has been assigned considering the relations in terms

of cooccurrence. The clustering technique used by VOSviewer is discussed by Waltman et al. (2010). The weights of a node use the number of occurrences of each keyword.

2.8 Criteria for discussion

The systematic review process requests us to examine every document among the selected cluster in the qualitative analysis process. However, only the most relevant works have to be discussed. To assess the relevance of every product, we have considered: the type of the work (scientific article, conference proceeding, book, chapters, etc.); the citations per year and the normalized citations per year; the AJG2018 rank of journals for scientific articles; and the pertinency of the title, keywords and abstracts with our research questions. We have obtained every relevant full-text document, read them, and discussed them in the following subsections topic by topic.

3. Discussion

3.1 Blockchain for accounting and auditing: from exploration to full exploitation

This topic includes 87 research products published between 1980 and 2021. We included here the most significant articles that are related to accounting in general, auditing or reporting.

Although blockchain was created in 2008 (Nakamoto, 2008), we can conventionally consider 2016 as the beginning of blockchain's era for accounting. (Schmitz and Leoni, 2019; Pimentel and Boulianne, 2020, Kokina et al., 2017b).

Similar to what Dumay et al. (2016) have done for intellectual capital, we have identified four blockchain accounting research area within this specific topic: understanding blockchain technology; designing accounting blockchain applications; building theory; test blockchain accounting information systems and their implications.

Area 1: Understanding blockchain technology

Since blockchain is a new technology, the first research area aims to discover what is and how blockchain works, which accounting and auditing problems can solve and the accountant's sentiment toward it. The studies in this phase are generally conceptual, aiming to build an ideal bridge between blockchain technology and accounting themes.

Blockchain attracted the accountant's interest for its immutability feature, but the academics expressed some initial skepticism. Immutability is a feature desired for accounting systems because it avoids manipulation, but how blockchain reaches these goals is one of the themes subjects to criticism. Coyne and McMickle (2017) even affirm that it is infeasible to take advantage of

blockchain for accounting. They notice that a public blockchain in accounting is not possible because entities would not like to make every accounting entry public and a private blockchain would not increase the assurance because it would not be immutable. In the same track, O'Leary (2017) investigates how every blockchain that is not public, decentralized, and peer-to-peer owns some differences from Bitcoin's one and for them exist some lacks that make these types of blockchains not better than other systems. So, he suggests adding the desired blockchain features to the existing system instead of replacing them (O'Leary, 2019).

Furthermore, blockchain itself does not assure that the recorded transactions have happened in the real world (Coyne and McMickle, 2017; Alles and Gray, 2020; O'Leary, 2018) Possible solutions are setting conflicting interests between involved parties by design (McAliney and Ang, 2019) or giving a digital ID of real-world objects (Alles and Gray, 2020). The latter suggests the complementarity between blockchain and IoT (Internet of Things) and RFID (Radio-Frequency Identification) (Sheldon, 2019).

Immutability and assurance improvement is not the only potential benefits that make academics interested in blockchain accounting systems. Other expected benefits are: reducing repetitive tasks, eliminating the need for reconciliation, enabling real-time accounting and continuous auditing, testing the entire database instead of a sample, reducing manual errors (Kwilinski, 2019; Sheldon, 2019; Turker and Bicer, 2020). Instead, other minor issues are related to compliance with and privacy laws (Rîndașu, 2019), latency, scalability, energy consumption (O'Leary, 2019), memory, anonymity, and irreversibility (Kwilinski, 2019).

In general, blockchain is not to be considered universally helpful in every contest (Rîndașu, 2019; McAliney and Ang, 2019, Al-Htaybat et al., 2019). According to McAliney and Ang (2019, p.171) blockchain could be a solution only if: there is a need for a common shared database, multiple parties are involved, parties have conflicting incentives and/or are not trusted, rules among participants are uniform, there is a need for an objective, immutable log, and the rules of transactions do not frequently change.

The blockchain's purpose of providing trust without intermediaries has raised concerns about the auditor's future and their role in society. However, so far, these worries are not justified because some aspects of the auditing process will still need professional judgment, and management assertions are relevant (Turker and Bicer, 2020). Some audit procedures as sampling, confirmation letters, looking at payrolls, checking invoices, reconciliation will become less expensive and obsolete (Turker and Bicer, 2020). Others such as systemic evaluation, risk assessment, predictive audits, and fraud detection will gain new and significant interest (Bonyuet, 2020).

Accountant and auditor roles might change, focusing more on non-automated activities. Auditors could extend their services to serve as administrators or advisors for accounting blockchain information systems (Bonyuet, 2020). Auditing procedures will need to keep pace to consider the new IT environment as the new accounting system is subject to control testing (Sheldon, 2019; Smith and Castonguay, 2020). For example, when entities use blockchain system, an auditor will have to consider: the governance; the relative power of the participants; the protocol to sign smart contracts and *dapps* (decentralized applications); the migration data procedure; the risk of forks; how the ERP and blockchain are connected; the right to access to data (Sheldon, 2019). On the other hand, blockchain data recovery and backup, or the unwilling change of data, will become less risky (Sheldon, 2019).

Tiberius and Hirth (2019) confirms that the auditor's perceptions align with academics who believe that the auditor's role will not be replaced by blockchain technology. Ferri et al. (2020) using an integrated theoretical framework between the technology acceptance model and the unified theory of acceptance and use of technology found that the performance expectancy and social influence mainly lead adoption intention of blockchain. Kend and Nguyen (2020) found that auditors are skeptical of the usefulness of blockchain for auditing. So, the essential benefits perceived by practitioners are not sure but seem to foresee a reduction of time-expensive activities and the others' opinions. Generally, it seems that they do not believe that blockchain applications will replace them.

A favorable accounting context in which blockchain could quickly be part of the standard is sustainability reporting. There is a need to improve the transparency and assurance of what entities disclose to avoid green-washing policies and practices. Furthermore, international standards are developing in these years, the same years in which blockchain is emerging (Bakarich et al., 2020).

Many research products have already contributed to highlight the essential feature and criticalities of blockchain in accounting. So, we agree with Pimentel and Boulianne (2020) that we do not need more research "*on what a blockchain is or high-level ruminations over how it could be used or abused*" (Pimentel and Boulianne, 2020, p. 342).

Area 2: Designing accounting blockchain applications

In this phase, researchers study how to implement blockchain into accounting, designing the data flow and architectural features. These studies are still not empirical, but they have a more practical approach because they have to describe how the system should work.

The first and the most cited paper in this area is Dai and Vasarhelyi (2017). They imagine adding at the usual double-entry system a third-entry on the chain. Their idea comes from Grigg (2005), who proposed a third entry recorded by a third-trusted party that stores the receipt that both parties involved in a transaction had agreed to and digitally signed. This system uses a permissioned

blockchain. The main achievement of Dai and Vasarhelyi (2017) was to introduce triple-entry bookkeeping into the academic discussion on blockchain and accounting. Moreover, they suggest increasing the automation of the system with RFID and smart contract to enable real-time accounting and continuous auditing.

Wang and Kogan (2018) extend the Dai and Vasarhelyi (2017) aiming to solve the trade-off between confidentiality and transparency propose the use of zk-SNARK (zero-knowledge verification) scheme and homomorphic encryption. In this way, the data stored in the blockchain can be validated and summed without revealing any details. McCallig et al. (2019) propose a blockchain system to overcome the confirmation letter audit procedure preserving privacy, using multiparty security and modular arithmetic. However, their system needs communication between all the entity customers or suppliers.

Rozario and Thomas (2019) suggest creating a second blockchain own by the auditor and connected to the first client's accounting blockchain. In this way, auditors could extract data from the firm's blockchain and perform smart-audit procedures in their blockchain. Regulators could check the audit procedures participating in the auditor blockchain. Tiberius and Hirth (2019) use blockchain to create a system to issue certificates of goods arrival relevant for VAT between two businesses located in different EU countries.

Although there are some proposals to use blockchain in accounting, there is no commonly accepted one yet. Interesting projects may come out from further action researches.

Area 3: Building theory

Researchers have worked to build a theory to explain how blockchain will change accounting. Some research products have utilized general framework such as The Technology-Organization-Environment (TOE) framework (Tornatzky et al., 1900), the technology acceptance model (TAM3) (Davis, 1989) and the unified theory of acceptance and use of technology (UTAUT) (Venkatesh et al., 2003). Many others lack a referred theoretical framework to analyze the phenomenon because they are a general overview of blockchain's possible use, benefit, and limitation in accounting (Pimentel and Boulianne, 2020).

We believe that a specific theory to explain the accounting blockchain could be obtained by the papers of Cai (2019) and Carlin (2019). They note that blockchain could lead a radical change into accounting, shifting to triple entry bookkeeping. The vantages of triple entry bookkeeping are that it increases transparency, reduces the time lag between fact and reporting, enabling real-time accounting, reduces the possibility of manipulation, and allows the complete audit of the whole record population (Carlin, 2019). It is relevant to note that exist two distinct concepts of triple-entry accounting (Cai, 2019). The first is the Ijiri (1986) that propose a third layer to measure the

momentum income. This idea did not reach success because it was too much complicated to implement. The second, which is one at accounting blockchain referring, is Grigg (2005). Grigg's (2005) triple-entry on blockchain makes transactions public recorded, so anyone cannot tamper or modify them. Furthermore, a blockchain accounting system could be integrated with smart contracts that "*can self-execute or self-enforce the agreements signed by two parties*" (Cai, 2019, p. 9).

Area 4: Test blockchain accounting information systems and their implications

Authors in the fourth area engage with empirical evidence and analysis. If the previous phases are conceptual, concerned with design, or theoretical, this one is more grounded in real-world experiences. The aim is to test how and why blockchain was being implemented.

Calderón and Stratopoulos (2020) present how to work the blockchain for the Listerine® supply chain, a mouthwash produced by J&J, a multinational pharmaceutical company. The Listerine management uses blockchain to assure the input's provenance and better coordination and trust between members. This system is built on the Hyperledger Fabric; it uses certificate authorities to provide an ID to the members and a determinist consensus protocol to mine the blocks through an ordering node. It is interesting in this system that although every peer maintains a copy of the chain, hence, it is decentralized, it exists a form of centralization because of the identity provider and the ordering node.

Cai (2019) cites three blockchain systems, but in these cases, when they are studied, they were more at an initial commercial phase than at a working one. They are: Luca™ by Ledgerium, a third ledger to records payment transactions between business parties; zkLedger™, by the MIT Media Lab, US, a privacy-preserving auditing for a distributed ledger; Pacio™ Solution, a blockchain ecosystem with triple-entry accounting.

This area is undeveloped because blockchain is a recent technology, and there are few use-cases to study (Pimentel and Boulianne, 2020). However, time is changing, and in the following years, we will have more opportunities. According to Karajovic et al. (2019) will reach a critical adoption mass in the next three years and will become mainstream in 2025.

3.2. The challenges of accounting for cryptoassets

This topic includes 11 research products published between 2018 and 2021. Here the research questions are related to whether crypto assets are items to be reported into financial statements and how to account them. Immediately linked to that issue is whether and how crypto assets represent taxable events.

Generally, cryptocurrencies fulfill the asset definition of the conceptual framework of IFRS because cryptocurrencies are assets according to the IFRS Conceptual Framework definition (“*An asset is a present economic resource controlled by the entity as a result of past events*”, par. 4.3) (Morozova et al., 2020; Pelucio-Grecco et al., 2020; Ram et al., 2016). Procházka (2018) states that cryptocurrencies can be presented as cash, financial asset (other than cash), non-financial investment, inventory, and intangible assets.

Account cryptocurrencies as cash fall under IAS21 “*The Effects of Changes in Foreign Exchange Rates*” if one adopts a broader definition of cash that goes beyond the legal tender status and include items generally accepted as means of payment (Procházka, 2018). Despite Pelucio-Grecco et al. (2020, p. 169) suggest to “*recognize this asset as foreign currency,*” this option is not widely accepted (Morozova et al., 2020).

We could consider accounting cryptos as financial instruments, taking into the account the speculative reason why companies buy and sell these items. According to IFRS9, this classification would allow the valuation at fair value. However, cryptocurrencies do not meet the financial asset definition provided by IAS32 par. 11 because they are not cash; an equity instrument of another entity; a contractual right to receive cash or another financial asset from another entity; a contract that will or may be settled in the entity’s own equity instruments (Procházka, 2018; Morozova et al., 2020).

If buying and selling cryptocurrencies was part of an entity ordinary business, it could be possible to account for cryptocurrencies as inventory. IAS2 par.9 states, “*Inventories shall be measured at the lower of cost and net realisable value,*” and, if the company is a broker-trader, can represent cryptos at fair value less cost to sell (Procházka, 2018; Morozova et al., 2020).

Finally, because cryptos fulfill the asset definition but are not tangible or other kinds of assets included within the scope of different principles than IAS38, they can be considered intangible assets. In this case, cryptos fall under the accounting rules for “*Intangible assets with indefinite useful lives*” (IAS 38.107), so they cannot be amortized but only impaired. Furthermore, if an active market exists, intangible assets can be evaluated at fair value (IAS 38.75) (Procházka, 2018; Morozova et al., 2020).

This debate was ended by the official interpretation by the IFRIC (IFRS Interpretations Committee, 2019) stating that the only way to comply with the IFRS principles is to account for cryptocurrencies as Intangible Asset (IAS38) or Inventory (IAS2). However, IFRIC (2019) left an opening point that in the future the accounting recommendation could change if some countries will adopt some cryptocurrency as legal tender or entities will adopt as the basis for their transactions.

Having companies with cryptocurrencies on their balance sheets also presents some auditing issues. The main obstacles are that there is not a third party, like a financial intermediary, to ask for

external confirmation, and the transactions in some cases are pseudo-anonymous. So, the whole auditing process on this matter relies on the company's internal control (Vincent and Wilkins, 2020).

Another similar context is taxation. There are two different situations for which crypto assets involve a taxable event: the mining activity and their exchanges (Volosovych and Baraniuk, 2018; Ram, 2018). Mining activity refers to the business to invest in equipment, hardware, and software computer, to produce crypto assets and sell them. It is a production event that “*should be taxed with general taxes depending on a taxpayer's legal status.*” (Volosovych and Baraniuk, 2018 p.103). The second situation includes all the different transactions that are simple exchanges of cryptocurrencies without adding any new units. In the latter case, no special fee shall be imposed, and it shall be taxed like every other event which involves foreign currency (Volosovych and Baraniuk, 2018).

To enforce the tax compliance on the exchanges of cryptocurrencies they could be regulated in the same way as the banking system. This would mean that national central banks would have the legal power to concede and revoke authorizations and monitor the intermediary activity which offers the service to buy and sell cryptocurrencies (Volosovych and Baraniuk, 2018).

Regarding taxation, two non-academic documents have attracted the attention on the matter because they are from authoritative entities in the major western economies. The Court of Justice of the European Union (2015) has decided that exchanges of cryptocurrencies are VAT exempt under the provision that exempts means of payment. The IRS (2014) of the United States of America declared that virtual currencies must be treated as properties.

To sum up, although there had been some doubt before the official interpretation provided by the IFRIC in June 2019, nowadays crypto assets should be accounted as Intangible Asset (IAS38) or Inventory (IAS2). Regarding taxation cryptocurrencies should be VAT exempt and for direct taxation should be treat as a production event for miners or as a exchanges of foreign currencies in all other occasions.

3.3 Blockchain and finance: threats and opportunities

Blockchain is born in the financial sector with the creation of Bitcoin. So, it is not surprising that scholars in the field of finance were among the first to study the implications of this technology.

This topic includes 54 research products that range from 2000 to 2021. One of the first research questions is whether cryptocurrencies could effectively replace and substitute fiat currencies. Polasik et al. (2015) highlighted that in countries with large shadow economy and low GDP per capita Bitcoin can work as a substitute for PayPal, payment cards, and cash on delivery. However, according to

Senner and Sornette (2019) cryptocurrencies will not replace fiat currencies because they do not entirely solve the complexity of monetary politics, not assuring price stability.

Involving a decentralized system implies governance issues. In a group of peers, there are no hierarchies so that no one can decide for the entire community. This poses challenges when some things go wrong and urgent decisions are needed. (Zachariadis et al., 2019).

Another part of the research focuses on studying cryptocurrencies financial performance (Trucíos, 2019; Liu et al., 2020). Alfieri et al. (2019) argue that bitcoin is like a common stock and provides an excellent risk-return profile. Since it is not correlated to existing asset classes, it represents an opportunity for portfolio diversification. However, cryptocurrencies are highly interrelated each other (Agosto and Cafferata, 2020, p. 13). Benedetti and Nikbakht (2021) have studied the effect of cross-listing, and they uncover an increase in price, trading volume, network growth, and on-chain activity around the date of first cross-listing. Polasik et al. (2015) found that the price of Bitcoin is influenced by the number and tone of newspaper articles and Google searches.

The advent of cryptocurrencies has also raised the question about the role of central banks. Nowadays, central banks continue to provide money supply, both virtually and physically. However, if physical money (cash) is accessible to anyone, virtual central bank money is restricted to few financial intermediaries. So, if people want fiat money have only two choices: use cash, which is relatively inefficient, or open a bank account, which involves counterparty risk. Berentsen and Schär (2018) suggest that central banks should not start new cryptocurrencies but should allow everyone to open accounts with them.

Blockchain, through smart contracts, has also created a new way to collect capital from the public without intermediaries that screen the projects and mandatory professional entities that check corporate governance practices before the fundraisings begin (Subramanian, 2020). So, in the absence of this form of investors guarantees (intermediaries involved), Giudici and Adhami (2019) found that the fundraise success depends on the project's team and the advisory committee's reputational capital at stake. According to Gan et al. (2021), the critical success factors are: the existence of a liquid secondary market; a minimum price-cost ratio of 2; a critical mass condition; and a maximum number of tokens. Gonzalez (2020) shows that P2P (peer to peer) lending decisions are influenced by the borrower's gender and herding behavior.

Finally, Autore et al. (2020) found that a firm's announcement to invest in blockchain leads to an increase of its stock's price. This positive market reaction does not suffer from a reversal effect if the announcement is credible in the sense that the blockchain's adoption is an advanced stage, contrary to a preliminary stage, or if it mentions blockchain in its quarterly or annual financial statements.

Finance was impacted by blockchain. This raised questions about the nature of cryptos, their function as a payment system, weakness, performance, and the role of central banks. Smart contracts have also created new ways to collect capital. Being blockchain an innovation, the financial market had also to value the companies that announced pursuing investment into this new technology.

3.4 The blockchain and business models

The success of cryptocurrencies has enticed entrepreneurs, academics, and practitioners to study their innovative underlying technology, the blockchain, and its opportunities in many different sectors. So, blockchain became a tool to innovate and could potentially disrupt and create new business models. This topic includes 42 products from 2004 to 2021.

The birth of the new millennium was welcomed by the emergent of a new industry: encryption software. Giarratana (2004), four years before the blockchain's invention, already discovered that this sector was a classical case where inventors become entrepreneurs and innovation is the key to open new markets and elude entry barriers. This finding could also explain the history of Bitcoin, which has created the new cryptocurrencies landscape beating incumbents into the financial sectors.

Blockchain could have use cases and innovate many sectors: for example, banking, financial markets, retail, supply chain, healthcare, manufacturing, governance, and insurance (Gaur, 2020). Into the financial sectors, beyond cryptocurrencies, it offers an opportunity to the entrepreneur who wants to create value reducing financial exclusion (Larios-Hernández, 2017). Cao *et al.* (2020) text mined the Chinese news reports related to InsurTech, technological innovation into the insurance industry, and found that from 2017 to 2019 “blockchain” is the key topic.

Mukkamala *et al.* (2018) suggest using blockchain in social business. Tiscini *et al.* (2020) explore the blockchain's adoption as a sustainable business model innovation in the agri-food industry. Bavassano, *et al.* (2020) focus on the shipping industry where blockchain can improve international administrative procedures but, a lack of standards, and the absence of one imposed by regulated, represent the highest barrier. Chan *et al.* (2020) propose blockchain for the luxury fashion brand to improve their CSR. Hojckova *et al.* (2020) study the success factor of blockchain-based peer-to-peer electricity trading. More generally, Hasan *et al.* (2020) demonstrated that blockchain increase operational efficiency, the managerial capability of the firm to transform various inputs into outputs, reducing the transaction costs.

Bolici *et al.* (2020) analyze the discussion about blockchain and tourism on Twitter. They highlight that public interest in this specific topic is high and positive. However, so far, the most tangible application of blockchain in tourism is cryptocurrencies that make local currencies

unnecessary (Treiblmaier et al., 2020). In the long term, blockchain could increase disintermediation, reducing the power of companies such as Uber, Lyft, and Airbnb that currently create value ensuring the reliability of their drivers or apartment owners (Rashideh, 2020).

To sum up, intermediaries base their profit on creating value by providing trust among different parties, which is valid for many industry sectors. Whether blockchain is a threat or an opportunity for them depends on how they approach innovations. Undoubtedly, blockchain no longer grants incumbents a stable future because they can be challenged by small inventors that might become entrepreneurs.

3.5 Blockchain potential in the supply chain

This topic includes 40 research products published between 2008 and 2021. Supply chain management refers to the activities of delivering goods from the suppliers to the consumers. Through this process, many different entities are involved, and there is a need to ensure a reliable information flow about the quality, origin, and delivery status of goods.

Chang *et al.* (2019) found that a blockchain-based supply chain process could enable instant tracking, reduce the cost related to updating information, improve cash liquidity, enable automatic payment, and, in general, improve automation. Choi, Feng, and Li (2020) argue that blockchain can reduce the information auditing cost, increase the proportion of information-sensitive consumers, and reduce demand volatility. Rodríguez-Espíndola et al. (2020) affirm that blockchain in the humanitarian supply chain might enhance the information flow: allowing real-time shared and secure information, boost the accountability of the use of financial resources, avoid duplication databases, and increase traceability of resource usage.

Blockchain might be helpful to account renewable energy and carbon credits that are intangible tradable items created to provide more financial incentives to the clean energy producer (Ashley and Johnson, 2018). On the same topic, Tang and Tang (2019) propose to use blockchain as an accounting tool to enforce the environmental policies and climate change strategies issued by governments.

Christ and V Helliard (2021) show that blockchain make also possible monitoring workers' rights but there are some privacy concerns to be addressed. Thomason et al. (2018) recap some other blockchain social applications: tracking financial flows from donors to the Poor; tracking results (accrual); account renewable energy; send remittances; and crowdfunding.

Kumar, et al. (2020) highlight some challenges: some contractual clauses are challenging to translate to formal and rigid computer programs; it is not possible to assure that every smart-contract is bug-free; in international business, it is a need to determine which jurisdiction will be used to solve

disputes, the redundancy and consensus protocol increase the storage and processing data cost, and finally secrecy and privacy are issue may arise. They state that the best blockchain implementation benefits are achieved when: the trust level among entities involved is low, there is a high need for traceability and visibility, privacy is not relevant, and the business model is not too cost-focused.

Van Hoek (2019) found that: the adoption rate of blockchain in the supply chain industries is low; the need for transparency and visibility motivates the implementation and the main barriers are the lack of understanding of how to integrate and leverage the investment on the blockchain

Some authors (Chang et al., 2019; Kumar et al., 2020) suggest that the future supply chain system will integrate blockchain into the current system and use a hybrid system with public on-chain data and private off-chain data. Furthermore, a huge complementarity emerges between blockchain and RFID (van Hoek, 2019), IoT, Internet of Things, and ERP, Enterprise Resource Planning (Kayikci et al., 2020).

4. Conclusions

The main aim of the present study was to review the literature on the utilization of blockchain in accounting practice and research and to define potential opportunities for further investigation.

The main findings in our central topic (accounting) are that the immutability feature of the blockchain is certainly desired by accountants and auditors and it should contribute to avoid earning manipulation and assure information and data. At the same time a public blockchain for accounting purposes is not yet adopted and the technology itself does not assure that the recorded transactions have happened in the real world (Coyne and McMickle, 2017; O'Leary, 2017 and 2019).

Nonetheless, many other advantages can emerge from blockchain technology, such as reducing repetitive tasks, eliminating the need for reconciliation, enabling real-time accounting and continuous auditing, testing the entire database instead of a sample, reducing manual errors (Kwilinski, 2019; Sheldon, 2019; Turker and Bicer, 2020).

However, it seems that blockchain cannot completely replace the role of auditors and assurance providers, but it could play a more central role in social and environmental accounting and reporting, especially for making unchangeable and assuring social and environmental data.

One more possible application is surely the triple-entry bookkeeping, with the third entry recorded on the chain (Dai and Vasarhelyi, 2017; Wang and Kogan, 2018) despite some issues of confidentiality and transparency that must be addressed and resolved.

However, the recent past and the near future of blockchain is surely anchored to the development of cryptocurrencies (second topic). While the problem of the representation and

valuation of cryptocurrencies in the financial statements following the IFRS interpretations commission can be considered clarified, significant audit and taxation issues remain, especially if there remains the need for a financial intermediary to ask for external confirmations. Moreover, in a context of very different national regulations, cryptocurrencies will likely not be able to completely replace fiat currencies (Senner and Sornette, 2019; Polasik et al., 2015) but the former are undoubtedly important forms of wealth investment for portfolio diversification (Trucíos, 2019; Liu et al., 2020).

According to our third (finance) and fourth (management and business models) topics, blockchain technology holds potentialities for innovating business models in many diverse sectors (Gaur, 2020), especially in socially or environmentally sensitive sectors or whereas the supply chain management is particularly complicated (Mukkamala et al., 2018; Tiscini et al., 2020; Bavassano et al., 2020; Chan et al., 2020; Hojckova et al., 2020). With reference to this latter, as highlighted in our fifth topic (supply chain), a positive application of blockchain is the possibility to assure the quality and the reliability of the value chain, especially in the manufacturing sectors, as pointed out by Calderón and Stratopoulos (2020). A blockchain-based supply chain process could enable instant tracking, preserve privacy through a private-chain with pre-authorization, reduce the cost related to updating information, enable automatic payment, and, in general, improve automation (Chang et al., 2019). This is particularly interesting in the energy sector, whereas renewable energy and carbon credits are intangible tradable items. Blockchain could even constitute an accounting tool to enforce the environmental policies and climate change strategies issued by countries (Tang and Tang, 2019). The application of blockchain to the supply chain management is particularly intriguing with reference to the monitoring of workers' rights, slavery, and unethical behaviors, because it contributes to track and assure the entire process.

Moreover, our SLR allows us to highlight potential future developments in blockchain for accounting and, more broadly, business studies.

First, in line with Secinaro et al. (2021), the research in the field of blockchain applied to accounting is primary qualitative and therefore we see the opportunity of future in-depth analysis testing new methods, including empirical and quantitative ones.

Second, the impact of blockchain on business model – and, in particular, in management and control of business sustainability - and in the supply chain management can be particularly significant: researchers may consider to fill this gap in the future.

Third, a certainly growing application of the blockchain concerns smart contracts (particularly in event, cultural and tourism sectors) and non-fungible token (especially in the world of art, thanks to high value digital reproductions that are completely unique) where this technology cannot only

constitute an automation and speed up of the process but must represent a standard of security, verifiability and authenticity of data.

Fourth, in our SLR emerges that a large part of the studies published is dedicated to blockchain in accounting, auditing and finance, but the impact on accountability remains relatively unexplored. In particular, the impact of blockchain on the broader concept of accountability that includes financial, social, and environmental data. Therefore, the issue of accountability based on blockchain represents a strong push for future research.

Fifth, in terms of impact on accounting, we can consider that blockchain can contribute improve the reliability of data, but with some problems of confidentiality and transparency that require validation by the active stakeholders, and assurance for controls and accountability.

Finally, among the possible developments of this study in terms of practical and theoretical applications of blockchain technology to accounting studies, we mention the possibility of overcoming the problem of data privacy through public blockchains. Already today, and to a greater extent next years, ledger managed by private blockchain monopolists can be replaced by systems of public blockchain that offer a possible better choice for enterprise users. The new generation of public blockchain solutions is already able to allow companies to use blockchain while maintaining complete data privacy.

However, in order to be affordable for everyone, blockchain solutions need to be industrialized and scalable to act efficiently on a large scale. In this perspective, it is essential that blockchain solutions can be integrated into Enterprise Resource Planning (ERP) systems and with RFDI, IoT and AI technologies, to create fast, reliable, and repeatable processes. If the blockchain integrates information and processes within and across company boundaries and it is in synergy with emerging technologies, it will make it possible to simplify and accelerate business processes, increase protection against cybersecurity and reduce or eliminate the roles of intermediaries.

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