

# The disruption of Blockchain in Auditing

## - A Systematic Literature Review and an Agenda for Future Research

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### Abstract

**Purpose** - This paper presents a systematic literature review, including content and bibliometric analyses, of the impact of blockchain technology (BT) in auditing, to identify trends, research areas, and construct an agenda for future research.

**Design/methodology/approach** – We include studies from 2010 to 2020 in our Structured Literature Review (SLR), using accounting journals on the Scopus database, which yielded 40 articles with blockchain and auditing at its core.

**Findings** – One of the contributions of our analyses is to group the prior research, and therefore also the agenda for future research, into three main research areas: 1) Blockchain as a tool for auditing professionals to improve business information systems to save time and prevent fraud; 2) Smart contracts enabling Audit 4.0 efficiency, reporting, disclosure and transparency; 3) Cryptocurrency and Initial Coin Offerings (ICOs) as a springboard for corporate governance and new venture financing. Our findings have several important implications for practice and theory.

**Implications for research and practice** – The results of our study emphasize that 1) the disruption of blockchain in auditing is in a nascent phase and there is a need for compelling empirical studies and potential for the involvement of practitioners; 2) there may be a need to reconsider audit procedures especially suited for digitalisation and BT adoption; 3) standards, guidelines, and training are required to pivot towards and confront the challenge BT will represent for auditing; and 4) there are two sides to the BT coin for auditing, enthusiasm about the potential and risk upon implementation. These practical implications can also be seen as a template for future research in a quest to align theory and practice.

**Originality/value** – Our SLR facilitates the identification of research areas and implications, forming a useful baseline for practitioners, professionals and academics, as we draft the state of the art on the disruption of blockchain in auditing, highlighting how BT is changing auditing activities and traditions.

**Keywords:** blockchain, auditing, accounting, distributed ledger technology, smart contracts, cryptocurrency, ICOs, token.

## 1. Introduction

In recent years, the landscape of accounting, auditing and accountability has experienced technological transformations (Bellucci and Manetti, 2017; Locke et al., 2018; Lombardi and Secundo, 2020; Troshani et al., 2019). For example, emerging issues deriving from the combination of smart technologies with accounting, auditing and accountability appear to focus on the renewal of professions and practitioners' activities and information governance, data, production and transmission as well as transparency, risks and trust in digital procedures. Thus, the digital revolution is changing practices and procedures performed in organisations, involving practitioners, professionals, academics, regulators and standard-setters (EY, 2017; Guthrie et al., 2019; Troshani et al., 2019).

Auditing (Humphrey, 2008; Solomon and Trotman, 2003) is increasingly disrupted by the digital revolution, and particularly blockchain technology (BT) or distributed ledger technology (DLT) (Coyne and McMickle, 2017; CPA and AICPA, 2017; Yermack, 2017). Although a unique definition of BT is not available (Ali et al., 2020; Alkhudary et al., 2020; Gaur, 2020), BT is able to reconfigure auditing. Schimitz and Leoni (2019, p. 331) argue that this domain is facing prominent issues of "governance, transparency and trust issues in the blockchain ecosystem, blockchain-enabled continuous audits, smart contract applications and the paradigmatic shift in accountants' and auditors' roles."

BT represents a digital distributed ledger capturing "transactions conducted among various parties in a network. It is a peer-to-peer, Internet-based distributed ledger, which includes all transactions since its inception. All participants (i.e., individuals or businesses) using the shared database are "nodes" connected to the blockchain, each maintaining an identical copy of the ledger. Every entry in a blockchain is a transaction that represents an exchange of value between participants (i.e. a digital asset that represents rights, obligations or ownership)" (CPA and AICPA; 2017, p. 3). According to Dermikan et al. (2020, p. 3), blockchain accounting is "public blockchains where every person has the access to the network and there is no network required to participate in the blockchain activities and transactions and private blockchains that are a more private and complex form of accounting in which the permission must be granted to an external person to join the groups."

Additionally, BT assumes several dimensions using the cryptography method and authentication transparency of the triple-entry ledger (Deloitte, 2018; EY, 2017; KPMG, 2016; PwC, 2018; Yermack, 2017) shared among involved parties. All parties must be involved to change each transaction (Swan, 2017). Bonyuet (2020, p. 32-33) states that "[m]ultiple transactions are bundled into a "block" along with the hash code from the header of the prior block, the time stamp, and the "nonce," which is a random number related to the proof-of-work algorithm." Among the first applications of BT, bitcoin cryptocurrency allowed developing a distinction between permissionless and permissioned transactions (Helliari et al., 2020). "Permissionless blockchains have become the domain of cryptocurrencies and financial markets. In contrast, permissioned blockchains have entered the domain of businesses and institutional practices." (Helliari et al., 2020, p. 1). All users can access permissionless blockchain (e.g. bitcoin blockchain), while permissioned blockchain limits "participation in the blockchain network to participants who have already been given permission by agreed-upon administrators" (CPA and AICPA, 2017, p. 8).

In recent years, several sectorial organisations introduced programs to increase practitioners' BT knowledge (Bonyuet, 2020). Thus, the Big Four are investing in BT (e.g. VeChain, Blockchain Analyser, Crypto-Asset

Accounting and Tax software, blockchain lab and platforms). Other organisations also consider it a priority to assure processes and relationships within all parties involved (Deloitte, 2020a). “Audit technologies can help reduce the length and complexity of audits.” and “The increasing impact of blockchain on industries and on internal controls over financial reporting also means that audit methodologies will need to evolve since the technology will introduce new risks related to the reliability of the blockchain, automated controls, and related-party transactions.” (Deloitte, 2020b). Thus, BT is changing auditing activities and traditions, providing a new way to control the ledger of recorded transactions and potentially changing the timing of audit activities and auditors’ sample collection (Brender et al., 2019; Deloitte, 2020b; Rooney et al., 2017; Tapscott and Tapscott, 2016).

This paper provides a review and critique of the literature on BT impact on auditing. It culminates in the development of an agenda for future research. The analysis answers several calls for research, including the AAAJ special issue “Accounting, accountability, and assurance: Blockchain and new forms of digital currency,” which included the following question: “How and under what conditions is blockchain going to disrupt auditing?” We applied a systematic literature review (SLR) (Kraus et al., 2020; Massaro et al., 2016; Petticrew and Roberts, 2006; Tranfield et al., 2003), using the Scopus database of accounting journals as the main source. Initially, 1,618 journal articles were extracted. From these, a final list of 68 articles published in academic journals was analysed. After careful analysis of these articles, we identified 40 articles with which to continue the content and bibliometric analysis, because these articles have blockchain and auditing at their core.

Our findings show BT is disrupting auditing. Our main research motivations follow: organisations’ increasing adoption of blockchain tools (e.g. distributed ledgers, smart contracts, cryptocurrency) in the accounting domain as also recalled in several calls for research. Thus, we draft the state of the art through identification of three emerging research areas: 1) Blockchain as a tool for audit professionals to improve business information systems to save time and prevent fraud; 2) Smart contracts enabling Audit 4.0 efficiency, reporting, disclosure and transparency; 3) Cryptocurrency and Initial Coin Offerings (ICOs) as a springboard for corporate governance and new venture financing. The results are a useful baseline for practitioners, professionals and academics. These results emphasize the nascent character of blockchain disruption in auditing and thus the need for compelling empirical studies and practitioners’ involvement. Additional implications are: to enhance understanding of the auditing procedures singled out for special treatment to re-think auditing and profession in the light of digitalisation and BT adoption; require standards and guidelines for spinning and guaranteeing the challenge towards BT in auditing, also improving digital ability by aligning theory and practice. Enthusiasm versus risks are the two sides of the coin. This paper is aimed to identify lessons learnt and research gaps, developing an agenda for future research.

This paper is organized as follows. After the introduction, Section 2 presents the method. Section 3 reviews the results while outlining insights and critiquing the literature. Section 4 discusses implications for theory and practice, while Section 5 concludes the document.

## 2. Research methods

In this section, we describe the methods used in our SLR to ensure reliability and validity (Dumay 2014; Massaro et al., 2016; Shah and Corley, 2006). SLR is directed to “contribute to developing research paths and questions by providing a foundation” (Massaro et al., 2016, p. 768) in several interdisciplinary fields, including auditing (Guthrie and Parker, 2011) and constructing the path towards the future research by posing new research questions. Thus, our research protocol was established following research steps by Massaro et al. (2016):

- (1) write a literature review protocol;*
- (2) define the questions that the literature review intends to answer;*

- (3) determine the type of studies and carry out a comprehensive literature search;*
- (4) measure article impact;*
- (5) define an analytical framework;*
- (6) establish literature review reliability;*
- (7) test literature review validity;*
- (8) code data using the developed framework;*
- (9) develop insights and critique through analysing the dataset; and*
- (10) develop future research paths and questions.*

We performed content analysis using Nvivo software and collected some bibliometric data (e.g. the occurrence of keywords) utilizing VOSwiew software. We describe the steps of our protocol in the following sections while providing new insights and critique (9) and future research (10) in Sections 3 and 4.

### 2.1. Write a literature review protocol

First, we adopted the SLR method (Kraus et al., 2020; Massaro et al., 2016; Petticrew and Roberts, 2006; Tranfield et al., 2003) to define BT impact as a disruptive tool for auditing, recognizing it as an innovative and promising research area. SLRs is useful in examining and drafting the state of the art in a specific research area (Pittaway and Cope, 2007), providing transparency and replicability (Tranfield et al., 2003; Armitage and Keeble-Allen, 2008; Kraus et al., 2020). Moher et al. (2009) argue that SLR sequence starts from keywords or combination of keyword searches focusing on specific areas. Senivongse et al. (2017) argue that SLR is suitable for identifying the literature developments in specific areas. Additionally, the literature review protocol provides “a description, rationale and proposed methods for the review question, and includes details of how different types of study will be located, appraised and synthesized” (Petticrew and Roberts, 2008, p. 44).

This SLR was motivated by several calls for research, including the AAAJ special issue “Accounting, accountability, and assurance: Blockchain and new forms of digital currency.” It included the research question: “How and under what conditions is blockchain going to disrupt auditing?” We address this question through our literature review, including the insights, critique, and development of a research agenda for future studies on BT impact on auditing.

BT impact in auditing remains relatively underexplored. In future, scholars must investigate its effects in organisations (e.g. public and private companies) and institutions in greater depth. Thus, our SLR is intended to portray the state of the art on this topic. We will provide insights, critique and develop a plan for future research in this field. Our main motivation is organisations’ increasing adoption of blockchain tools (e.g. distributed ledgers, smart contracts, cryptocurrency) in the accounting domain. Thus, the significance of the adoption of BT in public and private companies motivates this paper.

We searched accounting and other research peer-reviewed journals on the Scopus database from 2010 to 2020, which yielded 40 relevant and core articles. We selected our coding nodes from existing SLR (Dumay and Cai, 2014, 2015, Dumay, 2014) using articles and author demographics, research regions, research methods, and articles’ focus and contribution, adjusting some nodes characterizing our research topic (Table 1).

**Table 1: Nodes**

<b>Category</b>	<b>Variables</b>	<b>Results</b>
<b>Articles</b>	Scholars	100
	- <i>Academics</i>	97
	- <i>Practitioners</i>	3
	Average number of scholars per article	2.5
	Journal	27
	Year	2016-2020
	Overall Citations	479
<b>Region</b>	Australasia	5
	Europe	2
	North America	9
	Combination of Continent/Countries	4
	Other	1
	Not specified	19
<b>Research Method</b>	Qualitative method	36
	Quantitative method	4
	Mixed method	0
<b>Research Focus</b>	Blockchain or distributed ledger	26
	Smart contracts	3
	Cryptocurrency or ICO or Token	4
	Combination of previous topics	7

### 2.2 Define the questions that the literature review intends to answer

According to Alvesson and Deetz (2000, pp. 17-20), our research questions follow three specific tasks: “insight,” “critique” and “transformative redefinitions.” As summarized by Massaro et al. (2016), we established the following research questions:

*RQ1. How is research developing for inquiring into blockchain as a disruptive tool on auditing?*

*RQ2. What is the literature focus and critique within blockchain and auditing?*

*RQ3. What is the future for blockchain and auditing?*

The RQ1 and RQ2 are directed to define a “state of the art” of BT adoption and its impact on auditing (insights and critique). The RQ3 provides implications in the field of BT and auditing proposing the transformative redefinition.

### 2.3. Determine the type of studies and carry out a comprehensive literature search

We identified our analysis sources (Petticrew and Roberts, 2006) knowing that ours is an emerging research field recently investigated in light of the digital revolution’s advent. Thus, similar to Guthrie et al. (2012), we identified specialist/generalist accounting scientific journals and other relevant quality peer-reviewed journals on the Scopus database in combination and answering our research keywords. In turn, research keywords are originated by three relevant streams adopted in several calls for research, including the AAAJ call for papers. Although this research stream is relatively new, we scanned the past ten years (2010 to 2020) to ensure comprehensiveness. The total number of sources interrogated was 36.

Table 2: Source Title (alphabetical order)

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<i>Academy of Accounting and Financial Studies Journal</i>
<i>Accounting, Auditing and Accountability Journal</i>
<i>Accounting Forum</i>
<i>Accounting, Organisations and Society</i>
<i>Australian Accounting Review</i>
<i>Business Lawyer</i>
<i>Critical Perspectives on Accounting</i>
<i>Current Issues in Auditing</i>
<i>European Accounting Review</i>
<i>European Research Studies Journal</i>
<i>IEEE Engineering Management Review</i>
<i>Intelligent Systems in Accounting Finance and Management</i>
<i>International Journal of Accounting Information Systems</i>
<i>International Journal of Digital Accounting Research</i>
<i>International Journal of Recent Technology and Engineering</i>
<i>International Journal on Emerging Technologies</i>
<i>Issues in Accounting Education</i>
<i>Journal of Cleaner Production</i>
<i>Journal of Emerging Technologies in Accounting</i>
<i>Journal of Human Resource Costing &amp; Accounting</i>
<i>Journal of Intellectual Capital</i>
<i>Journal of ICT Standardisation</i>
<i>Journal of Industrial and Business Economics</i>
<i>Journal of Information Systems</i>
<i>Journal of International Accounting Auditing and Taxation</i>
<i>Journal of Management Analytics</i>
<i>Journal of Science and Technology Policy Management</i>
<i>Management Accounting Research</i>
<i>Managerial Finance</i>
<i>Meditari Accountancy Research</i>
<i>Quality Access to Success</i>
<i>Review of Finance</i>
<i>Review of International Business and Strategy</i>
<i>Strategic Change</i>
<i>The British Accounting Review</i>
<i>Wseas Transactions on Business and Economics</i>

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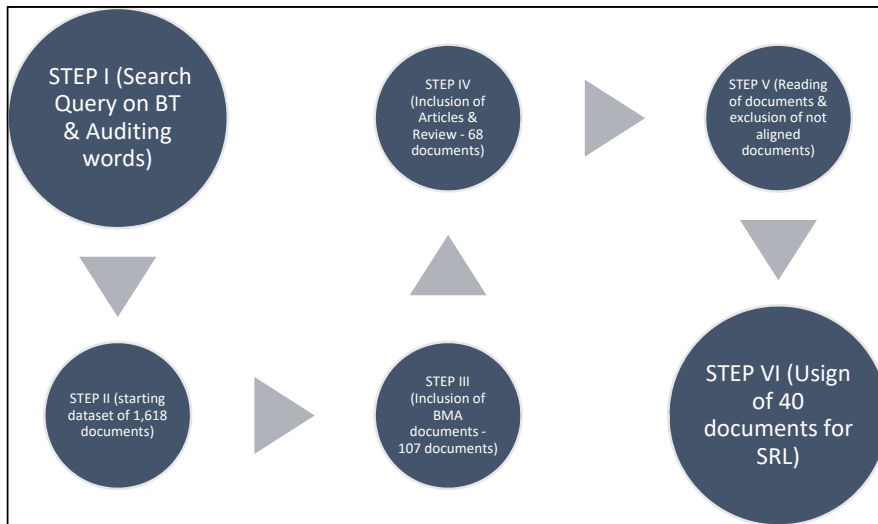
For all journals included in Table 2, we searched the keywords "blockchain" OR "distributed ledger technolog\*" OR "smart contract\*" OR "cryptocurrency" OR "ICO\*" OR "Token\*" as the relevant string to investigate the impact of blockchain on auditing (also using keywords "auditing" and "internal control"). We collected documents through the titles and/or abstracts containing previous keywords and also adopting the Boolean operator (AND; OR) as connection. We assumed articles and review excluding other categories of scientific publication (e.g. books, proceedings) to assure a literature analysis without grey areas (Kraus et al., 2020).

From 1,618 result documents, we highlighted 107 documents. Our final result was based on 68 research articles. After rereading the abstracts and the text, a final list of 40 core articles with a specific focus on our research theme was considered for this SLR. We excluded the total citations criteria in this step, because, being recently published, few of the papers have had the chance to garner citations. The full list of articles is included in Appendix A and the criteria are shown in Table 3. Figure 1 summarizes the transition from the total number of documents extracted to the final dataset.

**Table 3: Main SLR criteria adopted in this SLR**

Criteria	Description
Source	Guthrie et al. (2012) & Scopus database
Field	Business, Management & Accounting
Literature Typology	Research Articles & Review
Literature Language	English
Period	2010-2020
Keywords	Group of keywords Blockchain and Auditing
1st screening	Article title, Abstract, Keywords
2nd screening	Bibliometric analysis & text mining, content analysis

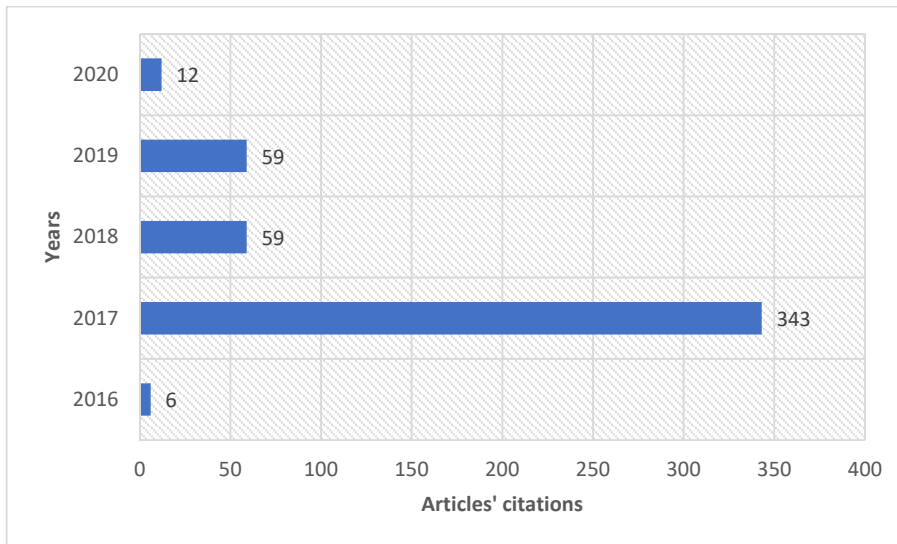
**Figure 1: Documents screening path**



#### 2.4 Measuring article impact

We measured the impact of articles collected, using the total number of citations and citations per year (CPY) for all articles published during 2016-2020. However, our research field is of recent interest to academics and such measures need to be contextualized to this new research field. Results by the citations analysis (overall 479 citations) (Figure 2) are compared with the total number of articles published per year (CPY) (Table 4). However, some articles with a high level of citations have more weight in the total number of citations per year. For example, in 2017 a high weight of citations are attributed to three articles: O’Leary (2017) 46 citations; Dai and Vasarhelyi (2017) 103 citations; Yermack (2017) 148 citations.

**Figure 2: Articles' Citations**



**Table 4: Articles and citations/citations per year (2016-2020)**

	YEAR					Total
	2016	2017	2018	2019	2020	
<b>Number of Articles</b>	1	6	4	17	12	40
<b>Citations</b>	6	343	59	59	12	479
<b>Citations per year</b>	0.16	0.02	0.07	0.2	1	

### 2.5 Define an analytical framework and establish a literature review reliability

We established a phase dedicated to defining the analytical framework. Particularly, three of the co-authors tested proposed nodes from existing SLR studies, confirming them as reported in Table 1. Given “units embedded in an analytical framework help researchers in organizing existing literature” (Massaro et al., 2016, p. 783), we adjust some nodes, owing to the specificity of our research topics (e.g. research method; research focus) and the sentiment on the recent introduction of a discussion on blockchain in auditing. However, all changes to the protocol were jointly analysed by all co-authors to ensure the reliability of coding nodes and results.

### 2.6 Test literature review validity and code data using the developed framework

According to Massaro et al. (2016, p. 785) “SLRs aim to answer specific research questions to map and assess existing literature.” Searching for the external and internal validity of this study, we re-called the Silverman (2013, p. 289) study: “we must overcome the temptation to jump to easy conclusions just because some evidence seems to lead in an interesting direction. Instead, we must subject this evidence to every possible test.” We followed White and McBurney (2012) to define the internal and external validity of our SLR searching for generalised results.



In this direction, we investigated the generalizability of our SLR results posing discussion aimed to show the literature validity. We focused only on articles published in the specialist/generalist accounting scientific journals listed in the Guthrie et al. (2012) study, plus other relevant quality peer-review journals on Scopus databases. Searching for specific keywords from the AAAJ call for papers allowed us to understand the state of the art in 2010-2020, guaranteeing the process quality of collected contributions. Our screening was devoted to selecting only core articles directed to answering the research questions, passing from 1,618 documents to 40.

In searching for internal validity, we adopted both the pattern-matching approach and the time-series analysis (Yin, 2014). First, we grouped a small cluster of articles (5 units) and then extended the analysis to all articles of our dataset. Second, we compared the number of articles and citations as reported in Section 4 below.

Additionally, our data coding was developed identifying important characteristics of studies (Stanley, 2001). According to Massaro et al. (2016, p. 787) "Since SLRs use a coding framework to analyse articles, it is important when analysing data that researchers define the technology to be used for the coding procedure," we used Nvivo software. Particularly, two authors manually coded articles and another one checked and resolved discrepancies. Results were used to develop insights, critique and transformative redefinition.

Lastly, we adopted a bibliometric analysis, using VOSviewer software (van Eck and Waltman, 2017) to perform the keywords and bibliographic analysis of articles collected highlighting emerging research topics (Silverman, 2013).

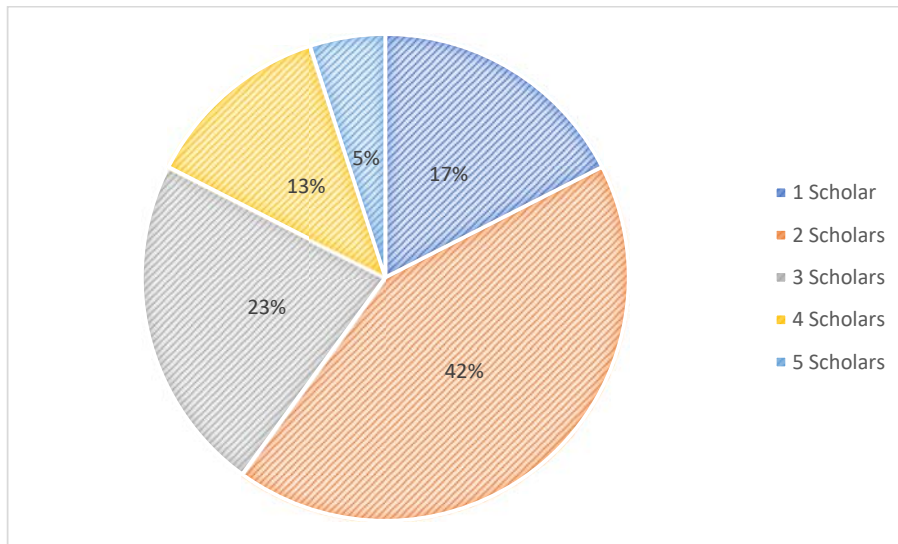
### 3. Insights and critique of findings through analysing the dataset

In this section, we present results of our SLR answering *RQ1. How is research for inquiring into blockchain as a disruptive tool on auditing developing?*; *RQ2. What is the focus and critique of the literature within the blockchain and auditing?* Thus, we propose insights and critiques of articles, author demographics, research regions, research methods, articles' focus and contribution.

#### 3.1 Articles and Author demographics

We started our analysis by verifying the number of Scholars involved in the 40 articles included in the dataset. We retrieve 100 Scholars with a total average of 2.5 authors per articles. Scholars involved in the articles analysed are 97 academics (researchers and professors) and 3 practitioners (e.g. policy manager or consultant). Additionally, articles published with one single-author are only 7 (17%). The other 32 articles were authored by up to five Scholars (83%) (Figure 3).

**Figure 3: Number of co-authors**



Our dataset is retrieved in 27 peer-reviewed journals, although 36 sources were interrogated as shown in Table 2. Only five journals published more than one article on the topic investigated in this research. Thus, the most influential journals or sources of articles published are included in Table 5. *Journal of Emerging Technologies in Accounting* represents the most relevant journal on the list, publishing 5 articles. Second, *International Journal of Accounting Information Systems* published 4 articles. We also report some information and major metrics of the top five sources (e.g. ranking ABDC; SJR2019; Scopus coverage) highlighting that only one source, *International Journal of Accounting Information Systems*, is included in the ABDC ranking's top-level ("A"). The other sources are ranked "B" by ABDC. Additionally, SJR2019 ranges between 0.31-0.62 and the Scopus coverage started between 1991 and 2010 for all journals. The oldest journal in Scopus is *Australian Accounting Review* (since 1991). The newest journal in Scopus is the *International Journal of Digital Accounting Research* (since 2010).

**Table 5: Number of publications per source (top five)**

Source	Number of Articles	ABDC	SJR 2019	Scopus coverage from
<i>Journal of Emerging Technologies in Accounting</i>	5	B	0.49	2009
<i>International Journal of Accounting Information Systems</i>	4	A	0.62	2000
<i>International Journal of Digital Accounting Research</i>	3	B	0.31	2010
<i>Australian Accounting Review</i>	3	B	0.39	1991
<i>Current Issues in Auditing</i>	2	B	0.52	2009

The publication trend in the theme investigated started in 2016. Thus, this is a relatively young research topic having an increasing trend, especially since 2019 (17 articles) and 2020 (12 articles). Following the citation analysis (Biemans et al., 2010; Garfield, 1989; Massaro et al., 2016), we highlight the trend of significantly increased citations in 2017 (343 citations). In 2018 and 2019, the trend achieved 59 citations. The citations per year (CPY) follow the same increasing trend.

Here, we included the list of top ten articles ranked by total citations and CPY in Table 6 following the criteria (e.g. the most prominent articles) by Serenko and Dumay (2015). Note that the authors on the list account for 87.8% of the total citations of our dataset, confirming their eminence and the criteria suggested by Schimmel (2011) to present and interpret data. The most cited article is by Yermack (2017) "Corporate governance and blockchains" with 148 citations (49.3 CPY).

**Table 6: Top ten articles (Citations; CPY)**

<b>AUTHORS</b>	<b>TITLE</b>	<b>YEAR</b>	<b>SOURCE TITLE</b>	<b>CITED BY</b>	<b>CPY</b>	<b>CPY Rank</b>
<b>Giudici, G., Adhami, S.</b>	The impact of governance signals on ICO fundraising success	2019	<i>Journal of Industrial and Business Economics</i>	11	11	6
<b>Schmitz, J., Leoni, G.</b>	Accounting and Auditing at the Time of Blockchain Technology: A Research Agenda	2019	<i>Australian Accounting Review</i>	12	12	5
<b>Ashley, M.J., Johnson, M.S.</b>	Establishing a secure, transparent, and autonomous blockchain of custody for renewable energy credits and carbon credits	2018	<i>IEEE Engineering Management Review</i>	11	5.5	10
<b>Wang, Y., Kogan, A.</b>	Designing confidentiality-preserving Blockchain-based transaction processing systems	2018	<i>International Journal of Accounting Information Systems</i>	31	15.5	3
<b>Rozario, A.M., Vasarhelyi, M.A.</b>	Auditing with smart contracts	2018	<i>International Journal of Digital Accounting Research</i>	14	7	8
<b>O'Leary, D.E.</b>	Configuring blockchain architectures for transaction information in blockchain consortiums: The case of accounting and supply chain systems	2017	<i>Intelligent Systems in Accounting Finance and Management</i>	46	15.3	4
<b>Dai, J., Vasarhelyi, M.A.</b>	Toward blockchain-based accounting and assurance	2017	<i>Journal of Information Systems</i>	103	34.3	2
<b>Adams, R., Parry, G., Godsiff, P., Ward, P.</b>	The future of money and further applications of the blockchain	2017	<i>Strategic Change</i>	25	8.3	7
<b>Yermack, D.</b>	Corporate governance and blockchains	2017	<i>Review of Finance</i>	148	49.3	1
<b>Umarovich, A.A., Gennadyevna, V.N., Vladimirovna, A.O., Alexandrovich, S.R.</b>	BlockChain and Financial Controlling in the System of Technological Provision of Large Corporations' Economic Security	2017	<i>European Research Studies Journal</i>	17	5.6	9

The most prolific authors, measured by the number of publications, are reported in Table 7. Only four authors published two articles. The other authors published one article.

**Table 7: Most prolific authors by the number of articles**

<b>Author</b>	<b>Articles</b>
Dai, J.	2
Rozario, A.M.	2
Vasarhelyi, M.A.	2
Vincent, N.E.	2

Additionally, the articles' geography underlines the prominent presence of scholars in the United States (19) and China (4). Table 8 shows the articles' top 8 geographic locations.

**Table 8: Article geography**

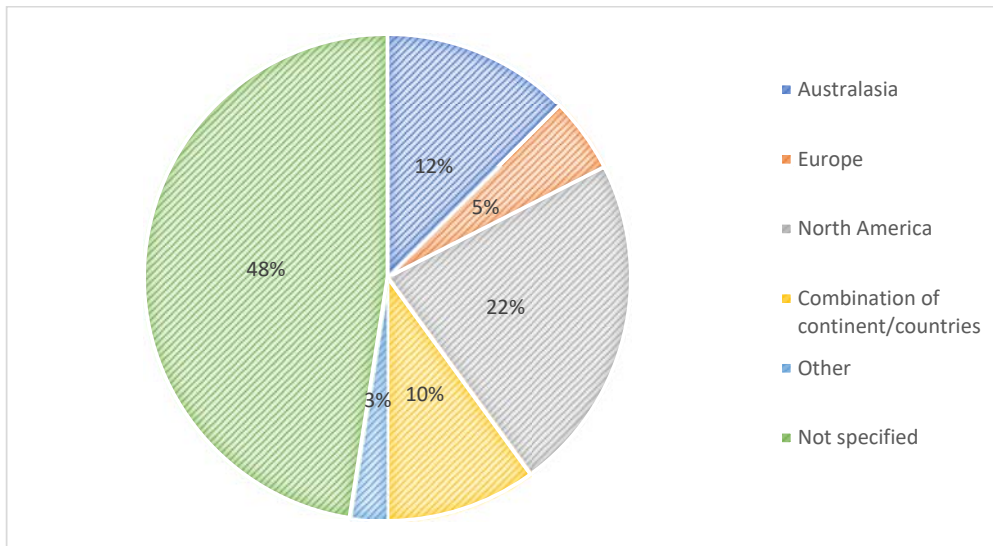
<b>Countries</b>	<b>Articles</b>
United States	19
China	4
Australia	4
India	2
Italy	2
Russian Federation	2
Singapore	2
United Kingdom	2

### 3.2 Geographical Regions of research

The geographical regions included in the scholars' dataset analysis are reported in this section. In several studies (Broadbent and Guthrie, 2008; Dumay and Cai, 2014; Dumay; 2014; Guthrie and Murthy, 2009; Guthrie et al., 2012), we discovered the most investigated geographical areas by adjusting some nodes by existing classifications. In our research, we included Europe, North America, a Combination of countries, Other and Not specified.

The most represented geographical region is North America with 9 articles (23%) followed by Australasia (13%) and the presence of multiple continents and/or countries researched (10%), such as USA and Europe, explaining auditing standards and regulations impacted by BT. The Europe investigation is represented in 2 articles (5%) while in the African continent (2.5%) is investigated the Other category. Additionally, we retain that 19 articles are not based on geographical regions in the light of the topic specificity (e.g. the influence of blockchain in the audit procedures) of investing in all countries (Figure 4). However, we are going to propose an understanding of this research focus in Section 4.4.

Figure 4: Geographical Regions of research

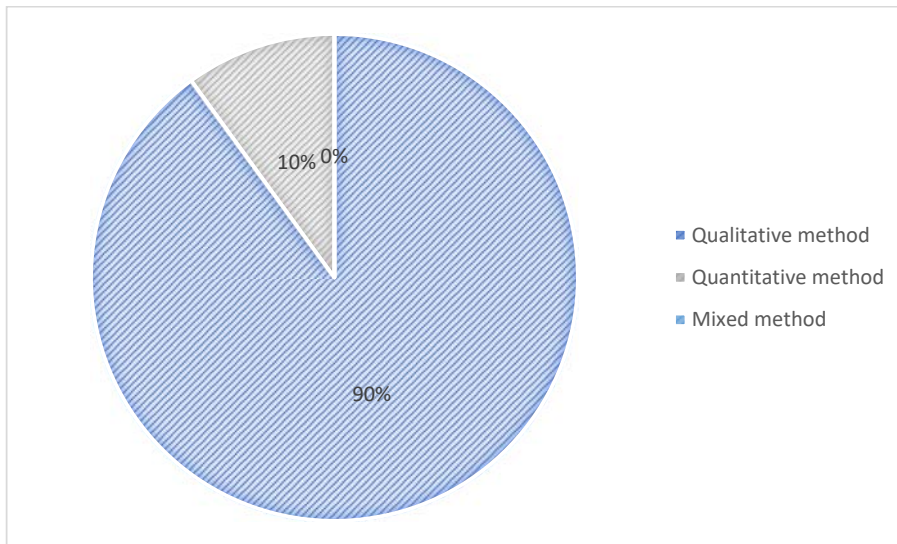


### 3.3 Research methods

According to many studies (Broadbent and Guthrie; 2008; Dumay, 2014; Guthrie and Murthy, 2009, Guthrie et al., 2012; Hoque, 2014; Parker, 2005; Serenko and Dumay, 2015), our analysis of the research methods simplified categories within the node “Research methods” in the light of the innovativeness of this topic, investigated only during last 4 years. Our analysis reveals that 36 articles were developed adopting a qualitative research method (90%) while only 4 articles are based on a quantitative method (10%) (Figure 5). In this scenario, the qualitative method follows prominent investigations based, for example, on the topic's conceptualisation and literature review (26 articles), case studies (5 articles) and survey (2 articles). Exploratory techniques and an integrated approach are also used (2 articles).

The quantitative method is underrepresented in our dataset following a general trend in the accounting studies focusing on BT impact (Scott and Orlikowski, 2012; Jeacle and Carter, 2011). We found statistical analysis (4 articles) adopting, for example, panel data analysis, social network analysis, and cryptography analysis. We retain such results aligned to the emerging topic we researched with this SLR. In this regard, many scholars needed to conceptualize and create a model explaining the first impact of BT in auditing (e.g. procedures, activities, risks) assuming several aspects and issues. In Section 4.4., we discuss the research focus of such studies.

Figure 5: Research Method



#### 4.4 Research focus/topic

The research focus/topic has been investigated following existing studies. Accordingly to Dumay (2014), Guthrie and Murthy (2009) and Guthrie et al. (2012), we mainly draft four categories in the node “research focus/topic.” The most relevant investigation refers to BT and its conceptualisation in auditing (26 articles – 65%). The combinations of several issues connected to BT, smart contracts and cryptocurrency in auditing are included in 7 articles (18%). Four articles are mainly based on cryptocurrency issues (10 %) and 3 articles are focused on smart contracts (8%).

In this scenario, application of the keywords analysis and bibliometric data through Nvivo and VOSwiew software is particularly useful in understanding the state of the art of BT as a disruptive tool on auditing and the literature’s focus and critique within blockchain and auditing.

First, common words in the dataset are researched through the frequency indicator, using words with a minimum of 5 characters. The Wordcloud below (Figure 6) and Table 9 rank the importance of words in this research. The most three frequent words are blockchain (4,598 times), audit (1,908) and accounting (1,497). All keywords of the 18 top-frequency words seem aligned to the previous classification of the research focus/topic.

Figure 6: Wordcloud

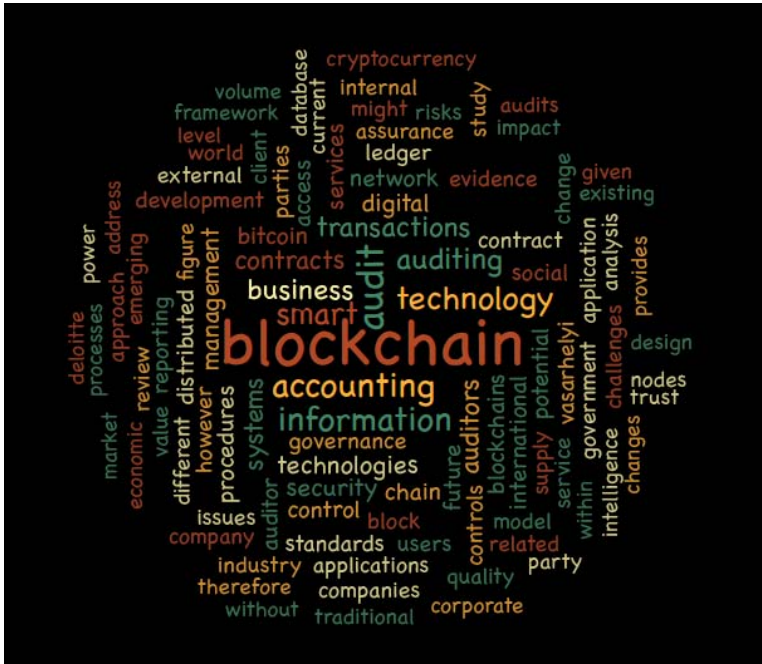


Table 9: Top 18 frequently used words

Word	Count	Weighted Percentage
Blockchain	4598	2.06%
Audit	1908	0.86%
Accounting	1497	0.67%
Information	1454	0.65%
Technology	1332	0.60%
Smart	1191	0.53%
Auditing	994	0.45%
Business	899	0.40%
Transactions	893	0.40%
Contracts	689	0.31%
Auditors	662	0.30%
Systems	659	0.30%
Technologies	559	0.25%
Management	558	0.25%
Digital	503	0.23%
Security	477	0.22%
Network	423	0.19%
Bitcoin	404	0.18%

According to Silverman (2013, p. 275), keyword analysis “is a method that allows you to analyse very large amounts of text without losing touch with focusing on small amounts of material in considerable depth.” We also aim to understand major keywords groupings or clusters in the dataset through social network analysis. Particularly, keywords are used by authors, editors and publishers to highlight significant themes in articles.



Such analysis showed five clusters, setting the software with a threshold (fulfilled) that groups together all keywords that must occur at least two times. The results of clusters and keywords are represented in Figure 7 and Table 10 below. The size of the spheres represents their relative importance (larger circles have connections to more articles) using the degree centrality measure (McCulloh et al., 2013).

Figure 7: Co-occurrence of all keywords

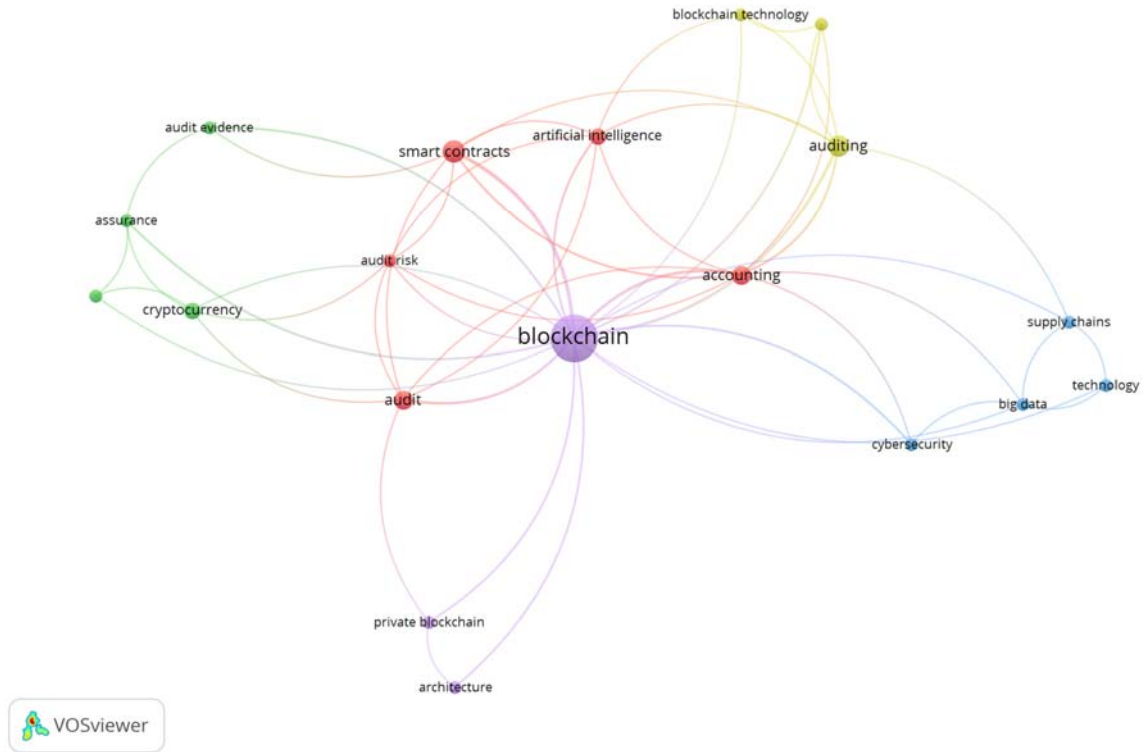


Table 10: Keyword clusters

Keyword clusters
Cluster 1 (red): accounting; artificial intelligence; audit, audit risk; smart contracts
Cluster 2 (green): assurance; audit evidence; corporate governance; cryptocurrency
Cluster 3 (blue) big data; cybersecurity; supply chains; technology
Cluster 4 (yellow): auditing; blockchain technology; distributed ledger technology
Cluster 5 (violet): architecture; blockchain; private blockchain

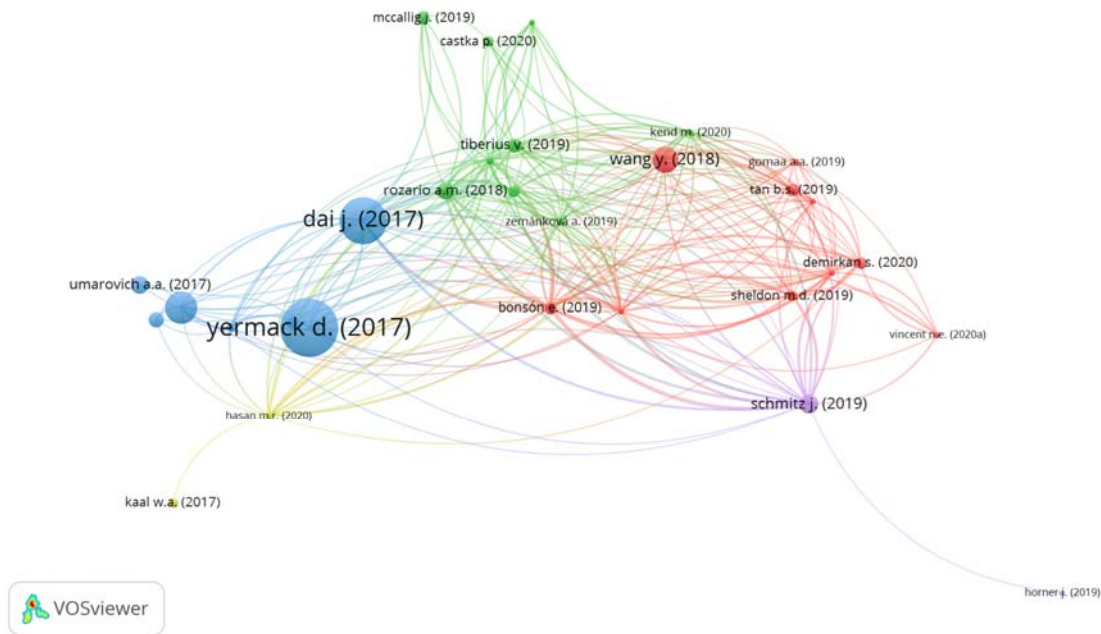


Main topics emerging from keyword analysis using Vos Viewer software seem to connect auditing to the following topics, even if sometimes a direct combination in the keyword's clusters (e.g. cluster 3) seems not highly relevant:

- i) Smart contracts;
- ii) Cryptocurrency;
- iii) Cybersecurity;
- iv) BT general issues;
- v) Private blockchain.

We also developed the content analysis using bibliographic pairing (Kessler, 1963; Van Eck and Waltman, 2009, 2014, 2017) applied to our dataset, also verifying the emergence of previous keywords. We used documents and sources; their relatedness was evaluated through articles sharing the same references (Boyack and Klavans, 2010). We found five clusters (Table 11; Figure 8) using the full counting and zero as a minimum number of citations. Each cluster should represent together those articles that may mark a specific topic/approach. Additionally, the modularity class reveals densely connected network nodes and identifies clusters of papers. We conferred and identified the main emerging research areas, based on reading the papers.

**Figure 8: Bibliographic clustering of articles**



**Table 11: Bibliographic clustering of authors**

<b>Cluster</b>	<b>Authors</b>
<b>Cluster 1 (red)</b>	Bonsón & Bednárová (2019) Bonyuet (2020) Canelón et al. (2019) Demirkan et al. (2020) Gomaa et al. (2019) Schmitz & Leoni (2019) Sheldon (2019) Smith & Castonguay (2020) Tan & Low (2019) Vincent et al. (2020) Wang & Kogan (2018)
<b>Cluster 2 (green)</b>	Dai et al. (2019) Kend & Nguyen (2020) Castka et al. (2020) Mccallig et al. (2019) Brown-Liburd et al. (2019) Rozario & Vasarhelyi (2018) Rozario & Thomas (2019) Tiberius & Hirth (2019) Zemánková (2019)
<b>Cluster 3 (blue)</b>	Dai & Vasarhelyi (2017) Giudici & Adhami (2019) Mosteanu & Faccia (2020) Mukkamala et al. (2018) O’leary (2017) Umarovich et al. (2017) Yermack (2017)
<b>Cluster 4 (yellow)</b>	Horner & Ryan (2019) Schmtz & Leoni (2019)
<b>Cluster 5 (violet)</b>	Hasan et al. (2020) Kaal & Calcaterra (2017)

This process allowed us to identify three main emerging research areas derived from an adjusted matching of topics among previous clusters. Thus, the articles are re-categorised into three research areas according to their focus (Table 12).

**Table 12: Clustering of documents and authors according to the research area**

RESEARCH AREA	AUTHORS	YEARS	CITATIONS	TITLE
<b>Research Area 1 – Blockchain as a tool for audit professionals to improve business information systems to save time and prevent fraud</b>	Castka, P., Searcy, C., Mohr, J.	2020	1	Technology-enhanced auditing: Improving veracity and timeliness in social and environmental audits of supply chains
	Demirkan, S., Demirkan, I., McKee, A.	2020	7	Blockchain technology in the future of business cybersecurity and accounting
	Bonyuet, D.	2020	1	Overview and impact of blockchain on auditing
	Smith, S.S., Castonguay, J.J.	2020	0	Blockchain and accounting governance: emerging issues and considerations for accounting and assurance professionals
	Kend, M., Nguyen, L.A.	2020	2	Big Data Analytics and Other Emerging Technologies: The Impact on the Australian Audit and Assurance Profession
	Tiberius, V., Hirth, S.	2019	7	Impacts of digitisation on auditing: A Delphi study for Germany
	Schmitz, J., Leoni, G.	2019	12	Accounting and Auditing at the Time of Blockchain Technology: A Research Agenda
	Tan, B.S., Low, K.Y.	2019	7	Blockchain as the Database Engine in the Accounting System
	Gomaa, A.A., Gomaa, M.I., Stampone, A.	2019	1	A transaction on the blockchain: An AIS perspective, intro case to explain transactions on the ERP and the role of the internal and external auditor
	Sheldon, M.D.	2019	3	A primer for information technology general control considerations on a private and permissioned blockchain audit
	Wang, Y., Kogan, A.	2018	31	Designing confidentiality-preserving Blockchain-based transaction processing systems
	Yermack, D.	2017	148	Corporate governance and blockchains
Alles, M., Gray, G.L.	2020	0	“The first mile problem”: Deriving an endogenous demand for auditing in blockchain-based business processes	
Vincent, N.E., Skjellum, A., Medury, S.	2020	0	Blockchain architecture: A design that helps CPA firms leverage the technology	

<b>Research Area 2 - Smart contracts enabling Audit 4.0 efficiency, reporting, disclosure and transparency</b>	Dai, J., He, N., Yu, H.	2019	0	Utilizing blockchain and smart contracts to enable audit 4.0: From the perspective of accountability audit of air pollution control in China
	Rozario, A.M., Thomas, C.	2019	3	Reengineering the audit with blockchain and smart contracts
	Yermack, D.	2017	148	Corporate governance and blockchains
	Rozario, A.M., Vasarhelyi, M.A.	2018	14	Auditing with smart contracts
	Canelón, J., Huerta, E., Incera, J., Ryan, T.	2019	0	A cybersecurity control framework for blockchain ecosystems
	Kaal, W.A., Calcaterra, C.	2017	4	Crypto transaction dispute resolution
	<b>Research Area 3 – Cryptocurrency and ICOs as springboard for corporate governance and new venture financing</b>	Hasan, M.R., Shiming, D., Islam, M.A., Hossain, M.Z.	2020	0
Giudici, G., Adhami, S.		2019	11	The impact of governance signals on ICO fundraising success
Mukkamala, R.R., Vatrappu, R., Ray, P.K., Sengupta, G., Halder, S.		2018	3	Blockchain for social business: Principles and applications
Dai, J., Vasarhelyi, M.A.		2017	103	Toward blockchain-based accounting and assurance
	Adams, R., Parry, T., Godsiff, P., Ward, P.	2017	25	The future of money and the blockchain

### **Research Area 1 – Blockchain as a tool for audit professionals to improve business information systems to save time and prevent fraud**

The first research area highlights BT's role in improving the audit profession and business information systems through time-saving and the avoidance of fraud. This is the most prominent research area among the identified clusters. Scholars highlight a changing auditing profession through several elements, although "audit practices are at the awareness or persuasion stage in relation to blockchain," whereas a small number (Kend and Nguyen, 2020, p. 279). Demirkan et al. (2020) argue the relevance of BT in changing the audit profession during the next years, transforming procedures and ensuring information privacy and protection. According to Demirkan et al. (2020), BT enabled new accounting practices, which has major cybersecurity implications. Demirkan et al. (2020) argue that in the audit profession, the examination of BT assures data reliability, data security and transaction transparency through a security trial model or cybersecurity (confidentiality, integrity and validity). Bonyuet (2020) analyses blockchain impact in auditing, including risks and changing procedures, and asserts the need for auditors to use effective and reliable tools for the

assurance of the business world and stakeholders. Thus, Bonyuet (2020) argue that auditors need to manage blockchain risks to reap the rewards; e.g., through the introduction of new standards, and the installation of audit modules in new BT systems to ensure efficient auditing. Smith and Castonguay (2020) similarly call for using BT to strengthen accounting and auditing governance and develop guidance for organisations and auditors focused on financial data integrity issues, financial reporting risks, and the implications for external auditors and corporate governance practices. Auditors should assess BT risks but could save time and money by using the blockchain's audit trail (Smith and Castonguay, 2020).

Bonsón and Bednárová (2019) propose an overview of BT and its architecture (private and permissioned; private and permissionless; public and permissioned; public and permissionless) in the accounting ecosystem, analysing transformation and implication in auditing. Bonsón and Bednárová (2019) highlight the reduction of economic uncertainty, agency costs and information asymmetry; increased transparency, auditability, trust and reliability; reduction of costs, human error and fraud; improved quality data; solution to privacy paradox, and supply chain transparency. Additionally, they argue that "blockchain enables the concept of distributed consensual accounting records (DCAR) to be introduced, [4] which adds new dimensions to accounting and has implications for continuous accounting, auditing, and reporting...once a transaction has been approved by the participants (nodes) of the block (e.g. the supplier, client, auditor, regulator, public administration), it is registered and cryptographically sealed, which guarantees the immutability of the data entry." (Bonsón and Bednárová, 2019, p. 732). Schmitz and Leoni (2019) review the accounting and auditing studies, highlighting the governance, transparency and trust issues in the blockchain ecosystem; blockchain-enabled continuous audits; smart contract applications and the paradigmatic shift in accountants' and auditors' roles as prominent and emerging themes. They argue that "...the technology increases the efficiency of recording, reconciling and auditing of accounting data. At the same time, BT allows accountants and auditors to save costs and time executing these tasks and reduces the risk of human error." Schmitz and Leoni (2019, p. 338). Additionally, "accountants and auditors must broaden their skillset and knowledge to be able to anticipate and meet the demands of their clients." Thus, Schmitz and Leoni (2019) emphasize the reduction of labour-intensive and time-consuming audit activities; auditors' generation, execution and control of smart contracts and their pivotal role in the regulation and implementation of BT as experts in record keeping, standard-setting and rule application. Tan and Low (2019) analyse the blockchain in the accounting domain, arguing that the audit's function in validating financial statements is influenced by digitisation: "Accounting transactions recorded in a blockchain are not automatically true and accurate. Deviations can still arise from errors or fraud. ...Digitising the paper-based validation process in a blockchain will generally reduce error rate, and also improve the efficiency of vouching and tracing required during an audit. A lower audit cost paradoxically means that the audit would be conducted to discover an improbable error rather than accepting the possibility of an error." (Tan and Low, 2019, p. 312).

While the study by Yermack (2017) analyses the implications of BT for managers, institutional investors, small shareholders, auditors, and other parties involved in corporate governance, Gomaa et al. (2019) investigate internal and external audit through the BT lens. Sheldon (2019) analyses the advantages of BT recognizing transparency in all transactions, immutable ledgers, and the potential for real-time auditing. Wang and Kogan (2018) underline the potentiality of BT in auditing fields, proposing blockchain-based transaction processing systems (TPS) and developing a prototype to demonstrate its functionality in real-time accounting, continuous monitoring and fraud prevention. For instance, they argue that the Blockchain-based Transaction Processing "continuously adds transactions to the blockchain and shares the blockchain with all users; therefore, auditors can obtain a full copy of his/her client's transaction data. The real-time availability of transaction data makes it possible for auditors to monitor the firm's global assets continuously. If an auditor wants to confirm a client's accounts receivable with its customers or accounts payable with suppliers, the auditor only needs to collect the relevant sales or procurement transaction data from the blockchain and perform analytical procedures" (Wang and Kogan, 2018, p. 4).

The auditing profession is also analysed by Alles and Gray (2020, p. 14) placing BT "within the context of the business environment in which it operates to understand the endogenous demand for auditing in that setting." Vincent et al. (2020, p. 1) develop a blockchain architecture "for organisations that will facilitate

effective connectivity to a blockchain while enabling auditors to leverage this technology to provide audit and assurance services." Thus, they emphasize the possibility to have continuous audit procedures for auditors' clients without adding integrations to the software. Castka et al. (2020) discuss veracity and timeliness in the auditing process's key steps such as data collection (e.g. accuracy, precision, completeness), recording and sharing (e.g. transparency, traceability), and analysis (e.g. timeliness, process errors) and interpretation. Tiberius and Hirth (2019) propose investigating possible changes in direction of the perception of auditing, the auditor–client relationship, regulations, structural and procedural changes for auditing firms, and the profile of the auditing profession adopting blockchain.

Taken together, the audit profession can use BT to improve business information systems, to save time and prevent fraud (Bonsón and Bednárová, 2019; Dermikan et al., 2020; Yermack, 2017). BT architecture in the auditing ecosystem assures data reliability, data security, information protection and privacy and transaction transparency to stakeholders adopting a cybersecurity model (Smith and Castonguay, 2020), as well as the reduction of costs, human error and fraud. Thus, a continuous auditing dimension emerged, shortening process time and allowing for the anticipation of client demands (Schimtz and Leoni, 2019; Vincent et al. 2020). Overall, real-time auditing (facilitated by BT) represents a tremendous opportunity for the audit profession (Castka et al., 2020).

## **Research area 2 – Smart contracts enabling Audit 4.0 efficiency, reporting, disclosure and transparency**

The second research area is more focused on the role of smart contracts in enabling Audit 4.0 to achieve efficiency and transparency using digital transaction protocol executing contract terms. For example, Dai et al. (2019) investigate the purpose of achieving real-time auditing and monitoring enabling Audit 4.0 through BT and smart contracts, which would change current audit procedures. Particularly, they develop a framework designing "a system to facilitate the continuous monitoring and accountability audit of air pollution control as a proof-of-concept case" (Dai et al. 2019, p. 23) ensuring audit improvement and workload reduction. Dai et al. (2019) highlight the data integrity and correct operation of intelligent auditing modules providing insights for auditors and governments. Rozario and Thomas (2019, p. 22) present a conceptual framework "for an external audit blockchain in which smart contracts, referred to as 'smart audit procedures' hereafter, can autonomously execute audit procedures and disclose audit procedures' results to participating users near real-time." An example is the vending machine smart contract "between a customer and a vendor and designed to accept a set of inputs based on pre-defined rules and dispense outputs; that is, transfer ownership, if those rules are met" (Rozario and Vasarhelyi, 2018). Rozario and Vasarhelyi (2018, p. 2340) investigate BT smart contracts as an emerging and "disruptive force that may change the way financial statement audits are performed and delivered" improving audit quality and transparent audit reporting. Thus, they propose "the application of smart contracts to auditing as an enabler for improved audit data analytics and close to real-time audit reporting" (Rozario and Vasarhelyi, 2018, p. 2340). Many other benefits are highlighted including the disintermediation, process efficiency deriving from the self-execution of smart contracts, trust in a trustless environment because all data are visible by participants, and mitigation of human errors and fraud risks. Kaal et al. (2017, p. 110) argue that "Smart contracts are computer-coded agreements that encumber the digital property, cryptocurrency, digital reputation, and so on, and then use mathematical logic to self-execute, self-enforce, and self-regulate." One of the most relevant examples is Ethereum platform: "applications that run exactly as programmed without any possibility of downtime, censorship, fraud or third-party interference. These apps run on a custom-built blockchain, an enormously powerful shared global infrastructure that can move value around and represent the ownership of property." (Kaal et al., 2017, p. 115). Canelòn et al. (2019, p.123) argue that "a nascent industry satisfies this need by offering to the audit of smart contract code where one or more auditors evaluate the code for vulnerabilities before its insertion into a blockchain."

To summarise, smart contracts promise enhanced efficiency, reporting, disclosure and transparency of all auditing activities (Dai et al., 2019; Rozario and Thomas, 2019). Audit 4.0 is starting to change the execution

of audit procedures and enables data visibility, disintermediation, self-execution of smart contracts, and trust in a trustless environment (Rozario and Vasarhelyi, 2018; Kaal et al., 2017). Smart contract platforms can be used to disclose audit procedures and their results to all parties involved in real-time while facilitating standardized procedures and common regulations.

### **Research area 3 – Cryptocurrency and ICOs as a springboard for corporate governance and new venture financing**

The third research area represents an extension of BT focused on the potentiality of cryptocurrency and ICOs in enhancing corporate governance and new venture financing. Both corporate governance and new venture financing have several connections to the auditing function within companies. These are interpreted as the premise to the development and implementation of auditing activities. Giudici and Adhami (2019) investigate the cryptocurrency and ICOs highlighting, through an empirical analysis, their benefits for entrepreneurship in obtaining new venture financing and a model of corporate governance that reduces transaction costs. Even if some risks exist (e.g. fraud and scamming), Giudici and Adhami (2019, p. 309) argue that “corporate governance is intended to have a pivotal role also in the success of the fundraising mechanism of ICOs, where entrepreneurial teams issued digital tokens in exchange for money, out[side] of any specific regulation and legal framework.” Mukkamala et al. (2018) argue that investment in social business is another key issue faced through cryptocurrency and the auditability of its activities. Mukkamala et al. (2018, pp. 96-97) propose the case of the Community Development Fund Community “which is an autonomous micro-credit-based community development program to promote economic empowerment of poor people through self-help employment and income generation by creating women entrepreneurs in Indian villages,” and identifying main stakeholders involved in the microfinance blockchain: investors, social business organisations, borrowers, and auditors. In this case, Dai and Vasarhelyi (2017) emphasize changes in the organisational context, transforming the business model by investing resources in BT and involving business partners in an open-share context influencing the mechanism of governance. Hasan et al. (2020, p. 175) investigate blockchain and its features “in the light of a transaction cost framework, so that governance decisions and, consequently, organisations as a whole become more efficient.” In their article, Adams et al. (2017, p. 420) discuss some studies including the Shermin Voshmgir studies: “article asks what sort of governance structures might emerge, given the apparent solutions provided by blockchain and algorithmic smart contracts to principal-agent conflict, and reduced transaction costs redefining organisational and national boundaries.” They also argue that “decentralized autonomous organisations are put forward as an example of DLT application beyond currency, employing smart contracts running on a blockchain to ‘govern’ according to preset rules among a consenting community” Adams et al. (2017, p. 420).

Overall, the introduction of cryptocurrency and ICOs tools facilitate enhanced corporate governance systems and new venture financing (Dai and Vasarhelyi, 2017; Giudici and Adhami, 2019). The adoption of open-share mechanisms influences business models and governance, impacting several domains, including auditing (Adams et al., 2017; Mukkamala et al., 2018). However, audit professionals will need specialized knowledge and skills and may consider assisting in the establishment of international regulation.

## **4. Research Implications**

This section discusses the main findings, providing critique and discussing implications for theory and practice (Silverman, 2013), as envisaged in *RQ3: What is the future for the blockchain and auditing domain?* In this regard, Alvesson and Deetz (2000, p. 9) argued that critical research is “oriented towards challenging rather than confirming that which is established, disrupting rather than reproducing cultural traditions and conventions, opening up and showing tensions in language use rather than continuing its domination,

encouraging productive dissention rather than taking surface consensus as a point of departure.” Thus, we discuss the critical issues we developed from insights gained to enable transformative redefinition.

### **Implication 1 – The disruption of blockchain in auditing is in a nascent phase and there is a need for compelling empirical studies and practitioner involvement**

Our study results clearly emphasize that blockchain disruption in auditing is in an early and promising phase (Scott and Orlikowski, 2012; Jeacle and Carter, 2011). This is an innovative and emerging topic influencing organisations, practitioners, professionals, academics, regulators and standard setters (EY, 2017; Guthrie et al., 2019; Troshani et al., 2019). Given the major influences and potential for disruption and change, and the scarcity of empirical evidence in the literature, there is a need for compelling empirical studies, especially in the light of the overwhelming proportion of conceptual articles in our dataset. The conceptualisations proposed in the extant literature can be seen as the groundwork for publication of compelling evidence and models built on empirical evidence to explain and understand BT influence in auditing. These investigations could focus on procedures, activities, timeliness, privacy, safeguards for corporate stakeholders, risks, etc. Scholars could also benefit from insights provided by practitioners in this nascent field, especially in the next research phase, which is bound to move towards evidence-based methods in which practitioner insights are likely to prove invaluable. Few of the studies in the extant literature are geographically oriented or context related (20 articles), and there could be major opportunities to learn from specific contexts where BT proves to be particularly successful. The combination of academics and practitioners in investigating context-rich real-life applications of BT can contribute to better understanding and an ongoing debate that would benefit the audit profession and stimulate the identification of even more research opportunities.

### **Implication 2 – Reconsider audit procedures especially suited for digitalisation and BT adoption**

The development of research on BT influence on audit must be considered in the light of systematisation of audit activities and procedures. Such a systematisation could open new research paths and approaches. Re-thinking auditing and profession in the light of digitalisation and adopting BT should also be considered in combination with existing functions in organisations (e.g. accounting, finance) to enhance data quality and information (Bonson and Bednarova, 2019). The improvement of data and information quality can firstly be researched regarding the accounting domain (e.g. completeness, interpretability, clarity, relevancy, timeliness); however, consideration could also be given to examining auditing procedures 4.0 regarding each organisational function in light of BT’s implications. Additionally, BT’s influence on continuous auditing must be researched, focusing on efficiency, reporting, disclosure, and transparency gains. Finally, BT’s smart contract and cryptocurrency dimensions/potential to enhance auditing must be researched and reported, to allow for the creation of new and/or standardized procedures in auditing.

### **Implications 3 – Required standards and guidelines to pivot towards and face the challenge that BT will represent for auditing, as well as training and education to align theory and practice**

Results developed in this analysis highlight the absence of a unique direction or authoritative guidance in applying BT to auditing. For example, very few studies mention or rely on the role of standard-setters and institutions in proposing guidance, standards or guidelines connected to digital issues (Castka et al., 2020; Mosteanu and Faccia, 2020; Vincent and Wilkins, 2020). Vincent and Wilkins (2020, p. a46) argue that “the lack of relevant official guidance from standard setters dealing with emerging issues related to cryptocurrencies is a major challenge for auditors.” Thus, BT implementation in auditing should be followed by adjusted principles, standards and guidelines directed to guaranteeing rights applications and disclosure, safeguarding organisations and stakeholders and reducing human errors in documentation. However, BT will involve a major disruptive change in the governance of organisations, which must be researched.



As the process towards digitalisation gathers momentum in auditing, the acquisition of technical BT knowledge will be important, requiring education and training. These activities will, in themselves, provide new opportunities for research.

#### **Implication 4 – The two sides of the coin, enthusiasm versus risks, as a template for future research**

The investigation of blockchain disruption in auditing allowed us to identify two sides of the coin, namely enthusiasm versus risks. Specifically, we highlight 1) several of the studies' enthusiasm to discover benefits in the adoption of blockchain in auditing, as a consequence of conceptualisation and theoretical propositions, while 2) the unexplored risks of these new technologies lurk in the background. For example, only a few studies explore the operational risks involved in adopting audit 4.0. Provisions; fraud and valuations represent such risks (Dai and Vasarhelyi, 2017; O'Learly, 2017; Yermack, 2017). According to Dai and Vasarhelyi (2017, p. 14), BT will require auditing to be more focused on "complex analysis, such as systemic evaluation, risk assessment, predictive audits, and fraud detection." However, another relevant risk derives from security and privacy, because of the public nature of the transactions in a distributed ledger (Wang and Kogan, 2018). The analysis of potential risks could follow the categories of public-private and centralized-decentralized blockchain as proposed in studies, such as Bonyuet (2020) and Bonson and Bednarova (2019). This proposal could be the starting point in investigating consequences derived from the adoption of blockchain technologies in auditing, since these consequences and risks are currently not well understood.

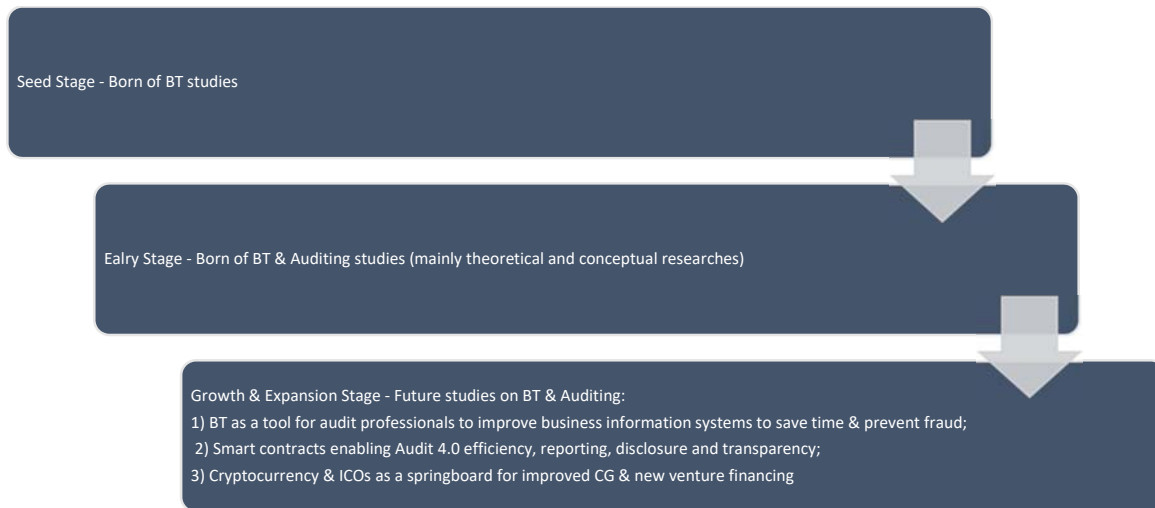
The four implications we described in this section could form "the basis and the justification for new research" (Massaro et al., 2016, p. 794), but can also be seen as a research synthesis, as argued by Stanley (2001, p. 131). Therefore, our study contributes to the literature by summarising prior research to identify implications for practice, designed to inspire new and innovative research.

## **5. Conclusions and an agenda for future research**

This SLR has been motivated by several calls for research, among them the AAAJ special issue "Accounting, accountability, and assurance: Blockchain and new forms of digital currency," and specifically the question "How and under what conditions is blockchain going to disrupt auditing?" We review the core literature on BT impact as a disruption in auditing, as this is a relatively underexplored research trend, impacting organisations and institutions in light of the advent of smart technologies.

Our results contribute to the existing literature (Ali et al., 2020; Bellucci and Manetti, 2017; Coyne and McMickle, 2017; CPA and AICPA, 2017; Helliar et al., 2020; Humphrey, 2008; Locke et al., 2018; Lombardi and Secundo, 2020; Solomon and Trotman, 2003; Troshani et al., 2019; Yermack, 2017) emphasizing that the disruption of blockchain in auditing is at an early stage because many studies are qualitative and conceptual in nature (36 articles) with only a few empirical studies (4 articles). Many studies are not geographically or context-specific (19 articles) and only three out of the 100 authors on BT are practitioners. In addition, the research topics tend to focus on general BT and distributed ledger issues, often proposing conceptual models. Few studies focus on the potential of smart contracts and cryptocurrency in the audit domain. Overall, we identified three emerging research area: 1) Blockchain as a tool for audit professionals to improve business information systems to save time and prevent fraud; 2) Smart contracts enabling Audit 4.0 efficiency, reporting, disclosure and transparency; 3) Cryptocurrency and ICOs as a springboard for improved corporate governance (CG) and new venture financing. Figure 9 shows the starting point of our research and the future direction for the research about this topic, assuming the seed, early and growth and expansion stages in the evolution of BT studies.

**Figure 9 – The research path of BT & Auditing**



According to Massaro et al. (2016, p. 701), “future research directions and questions are difficult to discover in a traditional authorship review because researchers will not be looking for these types of issues because they instead focus on interpreting contributions, findings and implications from an unstructured dataset.” Therefore, we call for compelling empirical studies and practitioners’ involvement in posing new research questions in the general areas of research we identified. New research projects are needed to provide new conceptualisations and models to explain BT influence in auditing, starting from procedures, activities, timeliness, privacy, corporate stakeholders’ safeguard, risks. Studies of unique context, as well as studies using new research methods for investigating the unique aspects of this new field, would also be useful to gain a better understanding of the issues involved.

However, this paper has certain limitations; e.g., our dataset includes only peer-reviewed articles published in journals on the Scopus database. However, Scopus is highly respected and includes a broad range of peer-reviewed journals. Additionally, the validity of results is dependent on the timing of this study. As this is an innovative topic, new studies are bound to continue to shed new light on and provide solutions to the consequences of BT on auditing. Finally, additional keywords may enable the identification of additional studies, which might be pursued by future studies. We agree with Massaro et al. (2016) when they state that an SLR is the starting point for new research journeys, instead of a perfect encapsulation of the field according to the prior research summarised in it.

Following previous research implications (section 4) to answering RQ3, our findings have several implications for practitioners, professionals and academics, including the following: 1) the disruption of blockchain in auditing is in a nascent phase; it requires compelling empirical studies and shows potential for practitioners’ involvement; 2) audit procedures especially suited for digitalisation and BT adoption may need to be reconsidered; 3) standards, guidelines, and training are required to pivot towards and confront the challenge BT will represent for auditing; and 4) there are two sides to the BT coin for auditing, enthusiasm about the potential and risk upon implementation. These practical implications can also be seen as a template for future research in a quest to align theory and practice.

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## APPENDIX A

AUTHORS	TITLE	YEAR	SOURCE TITLE	VOLUME	ISSUE
<b>Adams, R., Parry, G., Gotsiff, P., Ward, P.</b>	The future of money and further applications of the blockchain	2017	Strategic Change	26	5
<b>Alles, M., Gray, G.L.</b>	"The first mile problem": Deriving an endogenous demand for auditing in blockchain-based business processes	2020	International Journal of Accounting Information Systems	38	

<b>Ashley, M.J., Johnson, M.S.</b>	Establishing a secure, transparent, and autonomous blockchain of custody for renewable energy credits and carbon credits	2018	IEEE Engineering Management Review	46	4
<b>Bartosova, V., Voloshchuk, L., Romanovska, Y., Podra, O., Ivanyshyna, G.</b>	Directions of reduction of the audit risks in the conditions of the electronic economy	2019	Academy of Accounting and Financial Studies Journal	23	
<b>Bonsón, E., Bednárová, M.</b>	Blockchain and its implications for accounting and auditing	2019	Meditari Accountancy Research	27	5
<b>Bonyuet, D.</b>	Overview and impact of blockchain on auditing	2020	International Journal of Digital Accounting Research	20	31-43
<b>Brown-Liburd, Cheong, Vasarhelyi, and Wang</b>	Measuring with exogenous data (Med), and government economic monitoring (GEM)	2019	Journal of Emerging Technologies in Accounting	16	1
<b>Canelón, J., Huerta, E., Incera, J., Ryan, T.</b>	A cybersecurity control framework for blockchain ecosystems	2019	International Journal of Digital Accounting Research	19	
<b>Castka, P., Searcy, C., Mohr, J.</b>	Technology-enhanced auditing: Improving veracity and timeliness in social and environmental audits of supply chains	2020	Journal of Cleaner Production	258	
<b>Dai, J., He, N., Yu, H.</b>	Utilizing blockchain and smart contracts to enable audit 4.0: From the perspective of accountability audit of air pollution control in China	2019	Journal of Emerging Technologies in Accounting	16	2
<b>Dai, J., Vasarhelyi, M.A.</b>	Toward blockchain-based accounting and assurance	2017	Journal of Information Systems	31	3

<b>Demirkan, S., Demirkan, I., McKee, A.</b>	Blockchain technology in the future of business cyber security and accounting	2020	Journal of Management Analytics	7	2
<b>Gaur, N.</b>	Blockchain challenges in adoption	2020	Managerial Finance	46	6
<b>Giudici, G., Adhami, S.</b>	The impact of governance signals on ICO fundraising success	2019	Journal of Industrial and Business Economics	46	2
<b>Gomaa, A.A., Gomaa, M.I., Stampone, A.</b>	A transaction on the blockchain: An AIS perspective, intro case to explain transactions on the ERP and the role of the internal and external auditor	2019	Journal of Emerging Technologies in Accounting	16	1
<b>Grigoreva, E.A., Garifova, L.F., Polovkina, E.A.</b>	The future of digital technology in russia: Blockchain as one of the priority directions of development	2019	International Journal on Emerging Technologies	10	2
<b>Hasan, M.R., Shiming, D., Islam, M.A., Hossain, M.Z.</b>	Operational efficiency effects of blockchain technology implementation in firms: Evidence from China	2020	Review of International Business and Strategy	30	2
<b>Horner, J., Ryan, P.</b>	Blockchain standards for sustainable development	2019	Journal of ICT Standardication	7	3
<b>Kaal, W.A., Calcaterra, C.</b>	Crypto transaction dispute resolution	2017	Business Lawyer	73	1
<b>Kend, M., Nguyen, L.A.</b>	Big Data Analytics and Other Emerging Technologies: The Impact on the Australian Audit and Assurance Profession	2020	Australian Accounting Review	30	4
<b>McCallig, J., Robb, A., Rohde, F.</b>	Establishing the representational faithfulness of financial accounting information using multiparty security, network analysis and a blockchain	2019	International Journal of Accounting Information Systems	33	

<b>Mosteanu, N.R., Faccia, A.</b>	Digital systems and new challenges of financial management – fintech, XBRL, blockchain and cryptocurrencies	2020	Quality - Access to Success	21	174
<b>Mukkamala, R.R., Vatrappu, R., Ray, P.K., Sengupta, G., Halder, S.</b>	Blockchain for social business: Principles and applications	2018	IEEE Engineering Management Review	46	4
<b>O'Leary, D.E.</b>	Configuring blockchain architectures for transaction information in blockchain consortiums: The case of accounting and supply chain systems	2017	Intelligent Systems in Accounting Finance and Management	24	4
<b>Ozlanski, M.E., Negangard, E.M., Fay, R.G.</b>	Kabbage: A fresh approach to understanding fundamental auditing concepts and the effects of disruptive technology	2020	Issues in Accounting Education	35	2
<b>Ramtohol, A., Soyjaudah, K.M.S.</b>	Information security governance for e-services in southern African developing countries e-Government projects	2016	Journal of Science and Technology Policy Management	7	1
<b>Rozario, A.M., Thomas, C.</b>	Reengineering the audit with blockchain and smart contracts	2019	Journal of Emerging Technologies in Accounting	16	1
<b>Rozario, A.M., Vasarhelyi, M.A.</b>	Auditing with smart contracts	2018	International Journal of Digital Accounting Research	18	
<b>Schmitz, J., Leoni, G.</b>	Accounting and Auditing at the Time of Blockchain Technology: A Research Agenda	2019	Australian Accounting Review	29	2
<b>Sheldon, M.D.</b>	A primer for information technology general control considerations on a private and permissioned blockchain audit	2019	Current Issues in Auditing	13	1



<b>Smith, S.S., Castonguay, J.J.</b>	Blockchain and accounting governance: emerging issues and considerations for accounting and assurance professionals	2020	Journal of Emerging Technologies in Accounting	17	1
<b>Swapna, D., Madhuri, A., Sri Lakshmi, T., Phani Praveen, S.</b>	An efficient distributive framework for preserving data privacy through block chain	2019	International Journal of Recent Technology and Engineering	8	2
<b>Tan, B.S., Low, K.Y.</b>	Blockchain as the Database Engine in the Accounting System	2019	Australian Accounting Review	29	2
<b>Tiberius, V., Hirth, S.</b>	Impacts of digitization on auditing: A Delphi study for Germany	2019	Journal of International Accounting, Auditing and Taxation	37	
<b>Umarovich, A.A., Gennadyevna, V.N., Vladimirovna, A.O., Alexandrovich, S.R.</b>	Block Chain and Financial Controlling in the System of Technological Provision of Large Corporations' Economic Security	2017	European Research Studies Journal	20	3
<b>Vincent, N.E., Skjellum, A., Medury, S.</b>	Blockchain architecture: A design that helps CPA firms leverage the technology	2020	International Journal of Accounting Information Systems	38	
<b>Vincent, N.E., Wilkins, A.M.</b>	Challenges when auditing cryptocurrencies	2020	Current Issues in Auditing	14	1
<b>Wang, Y., Kogan, A.</b>	Designing confidentiality-preserving Blockchain-based transaction processing systems	2018	International Journal of Accounting Information Systems	30	
<b>Yermack, D.</b>	Corporate governance and blockchains	2017	Review of Finance	21	1
<b>Zemánková, A.</b>	Artificial intelligence and blockchain in audit and accounting: Literature review	2019	WSEAS Transaction on Business and Economics	16	