Review Paper

European Journal of Digital Economy Research
2023 Vol.4 Issue.1 pp.19-31

REDEFINING AUDITING IN A BLOCKCHAIN ERA: OPPORTUNITIES AND OBSTACLES FOR EXTERNAL AUDITORS

Sinem Duygu KAPCI *

* 100/2000 CoHE Ph.D. Candidate, Izmir Kâtip Celebi University, Institute of Social Science, İzmir-Turkey, duygukapcihmo@gmail.com, https://orcid.org/0000-0002-1657-0177.

ABSTRACT

The characteristics and mode of operation of blockchain technology could transform the accounting and auditing industries. The technological advancements introduced by Blockchain are anticipated to significantly influence reporting and auditing procedures, particularly within accounting information systems. The escalating adoption of blockchain technology is poised to alter the comprehensiveness and caliber of information accessible to auditors, thereby impacting the auditing process. Consequently, it is imperative for professionals in accounting and auditing to grasp both the prospects and impediments posed by these innovative technologies. This study endeavors to scrutinize the role of blockchain within the realms of accounting and auditing, both within existing literature and in professional practice.

Keywords: *Blockchain, Triple-Entry Accounting, Auditing, Smart Contract, Literature review.*

1. INTRODUCTION

Blockchain technology, originating from the creation of bitcoin by Satoshi Nakamoto in 2008, stands as a decentralized digital payment system (Nakamoto, 2008). The exponential surge in the market value of bitcoin, reaching over $200 billion in 2017 (Popper, 2017), heralded its prominence as the pioneering application of blockchain technology. Forecasts indicate the burgeoning growth of the blockchain market, projected to escalate to $39.7 billion by 2025 (Statista Research Department, 2023).

Emerging as a quintessential "trust protocol," blockchain technology is witnessing widespread adoption across diverse sectors, commencing notably within the domains of banking and finance (Raj, 2017). Noteworthy technology behemoths such as IBM, Microsoft, and Intel are actively investing in this transformative technology (Medium, 2019). Moreover, the burgeoning interest in blockchain has permeated the realms of accounting and auditing (Bonsón & Bednárová, 2019; CPA Canada, 2017; Dai & Vasarhelyi, 2017; Smith, 2018), with major audit, accounting, and consulting firms like PwC, Deloitte, KPMG, and EY venturing into pilot applications of blockchain technology (Blockchain Türkiye, 2021).

IFAC (2017) posits blockchain as a fundamental solution for ensuring reliable records in various contexts, highlighting its disruptive potential in finance and its envisioned application in inter-organizational records such as accounting. The advent of blockchain technology is anticipated to significantly influence reporting and auditing procedures, especially within accounting information systems. Its increased utilization is poised to impact the depth and quality of information provided to auditors, thereby altering the trajectory of the audit process. Consequently, it becomes imperative for accountants and auditors to comprehend the intricate prospects and hurdles introduced by these technological advancements.

This paper endeavors to delve into the role of blockchain within the accounting and auditing spheres as reflected in academic literature and professional practice. It aims to dissect the emergent concerns pertinent to the future of blockchain in accounting and auditing, categorically exploring (i) the evolution of accounting methodologies, (ii) pivotal developments in accounting and auditing practices along with the evolving auditor profile, and (iii) the discernible opportunities and challenges posed for auditors within this transformative landscape.

2. OVERVIEW OF BLOCKCHAIN CONCEPT

Satoshi Nakamoto, in his seminal white paper titled "Bitcoin: Peer-to-Peer Electronic Cash Payment System," delineated blockchain technology as an emergent innovation (Sherman, Javani, Zhang, & Golaszew, 2019; Elommal & Manita, 2021; Nakamoto, 2008). One of its early applications materialized in bitcoin, introducing a cryptocurrency paradigm as an alternative to conventional centralized currencies (Fuller & Markelevich, 2020).

While commonly associated with cryptocurrencies, blockchain technology fundamentally operates as a public, decentralized distributed ledger system. It ensconces transactions between users within an immutable, verifiable, secure, and chronological framework (Swan M., 2015; Allen, 2011; Sakız & Gencer Geç, 2019; Yaga, Mell, Roby, & Scarfone, 2019). Employing distributed ledger technology, blockchain leverages independent computers (nodes) to record, share, and synchronize transactions across electronic ledgers, diverging from the centralized data repositories characterizing traditional ledgers (Otero & Fink, 2021).

Defined in the 2018 report by the World Economic Forum, blockchain technology epitomizes a decentralized electronic ledger system that establishes cryptographically secure and immutable records of various value transactions, encompassing money, goods, property, labor, or votes. Its versatile functionalities encompass facilitating peer-to-peer payments, managing records, tracking physical objects, and executing value transfers through smart contracts. As highlighted by Herweijer et al. (2018), this technology harbors immense potential to redefine operational landscapes across business, governance, and societal domains.

2.1. The Characteristics and Benefits of Blockchain Technology

Decentralization and Distribution

Ledgers, an enduring mechanism facilitating the tracking of goods, services, assets, and payments across historical contexts, retain a pivotal role in modern economic and social activities. Traditionally, centralized systems have been instrumental in managing intricate transactions involving multiple stakeholders. These systems necessitate a trusted third party to validate and input transactions into established ledgers, ensuring the prevention of duplication or misuse and preserving transaction histories (Rejeb, Rejeb, & Keogh, 2021; Mainelli & Smith, 2015).

Blockchain technology, distinguished by its decentralized information storage and transmission framework, embodies a fundamental departure from conventional centralized systems. It engenders secure transactions without reliance on a central network for control or administration. Upon publication throughout the system, each new transaction undergoes verification by existing nodes, subsequently becoming recorded as a new node within the chain upon approval. Notably, the validation of transactions within the network is conducted by extant nodes rather than a designated central authority (Elommal & Manita, 2021; Smith, 2020).

Consensus Algorithms

Consensus mechanisms are presented as a solution to the insecurity of data distributed in a decentralised network. The essence of this system is to solve the trust problem that exists in decentralised structures.

Proof of Work (**PoW**)

Proof of Work (PoW) stands as the consensus algorithm underpinning the Bitcoin network. This algorithm operates to integrate new transaction blocks into the blockchain via a process termed "mining." Each block undergoes a verification procedure, validating the entire chain to ensure the creation of a secure system. Consequently, the processing time for each block extends to approximately

10 minutes. However, this system is encumbered by drawbacks, notably prolonged processing periods and heightened energy consumption. A critical vulnerability inherent in PoW lies in the potential for a group of miners to amass control over 50% of the network, paving the way for the execution of fraudulent blocks, thereby initiating a "51% attack." This attack compromises the immutability of the blockchain by fracturing the longest chain, posing a fundamental risk to the decentralized nature of the system. This inherent risk of mining centralization has spurred a quest among stakeholders to explore and devise alternative methodologies (Appelbaum, 2021; Werbach, 2018; Zhang, Wu, & Wang, 2020; Zheng, Xie, Dai, Chen, & Wang, 2017; Raikwar, Gligoroski, & Kralevska, 2019; Kardaş, 2019).

Proof of Stake (PoS)

Proof of Stake (PoS) emerges as an alternative consensus mechanism utilized in public blockchain networks. King and Nadal (2012) proposed this peer-to-peer cryptocurrency consensus model in response to the elevated energy demands and transaction expenses inherent in Nakamoto's proof-of-work design. PoS-based blockchain networks ascertain the issuance of new blocks based on the quantity of shares held by a user. Unlike the resource-intensive computations integral to proof-of-work, this consensus model circumvents the necessity for extensive time, electricity, and processing power (Kim, 2021).

Transparency and Traceability

Blockchain technology ensures transparency and traceability by immutably storing transactions, which are shared and recorded by nodes (users) within the network. This foundational characteristic guarantees system longevity and consistency by replicating records across independent computers, thereby fostering heightened user trust (Elommal & Manita, 2021).

Cryptographic Assurance

Cryptography serves as a fundamental method for safeguarding data against unauthorized access. Blockchain technologies establish a trusted framework for distributed data storage and value exchange, employing cryptographic foundations. Within blockchain systems, cryptographic techniques play a pivotal role in upholding ledger integrity, thereby ensuring the immutability of blockchain data. This resilience prevents any alteration of transaction information stored in the blockchain, both during and after block creation. Primarily, blockchain relies on cryptographic hash functions and digital signature methods to reinforce its security measures (Dinh et al., 2018; Choudhary, 2022).

Evolution of Blockchain: Smart Contracts

The emergence of smart contracts within blockchain technology marks a substantial stride forward (CPA Canada, 2017). Notably, the concept of smart contracts, as envisioned by Nick Sbazo, dates back to the 1990s. However, the practical execution of smart contracts without the involvement of intermediaries only became viable following the advent of blockchain (Gamage, Weerasinghe, & Dias, 2020). Ethereum stands out as the pioneering blockchain platform expressly designed to accommodate smart contracts and decentralized applications (Werbach, 2018; Gamage, Weerasinghe, & Dias, 2020). Across various disciplines, smart contracts find diverse definitions; broadly, they can be construed as "agreements capable of automation and enforceability."

Blockchain Types

Blockchains are often categorized based on their design, data accessibility, and access control mechanisms. In academic literature, these classifications are commonly delineated as "public" and "private" (Sarmah, 2018; Rejeb, Rejeb, & Keogh, 2021; Ünal & Uluyol, 2020) or alternatively as "permissioned" and "permissionless" (El Ioini & Pahl, 2018; Yaga, Mell, Roby, & Scarfone, 2019). Nevertheless, these terms are frequently used interchangeably in both research and practical blockchain applications. While the classification of blockchains remains somewhat ambiguous in the literature, two primary types have garnered attention: "public" versus "private," or "permissioned" and "permissionless" blockchains.

Permissionless blockchains resemble the unrestricted accessibility of the public internet, allowing anyone to join. Functioning as public, decentralized ledger platforms, these networks generate blocks without requiring authorization from a governing body. Given the universal publishing rights, nodes within the network possess read access to the blockchain and can conduct transactions. Prominent examples of permissionless blockchain networks encompass Bitcoin, Ethereum, and Zerocash platforms.

Contrarily, permissioned blockchains demand authorization for users publishing blocks, either from a centralized or decentralized authority. As these networks are safeguarded by authorized users, they can regulate both read access and transactional capabilities. Organizations seeking collaborative endeavors while harboring partial trust amongst themselves often leverage permissioned blockchain networks. These networks offer advantages in terms of speed and cost efficiency, particularly within corporate environments, rendering them anticipated to witness heightened adoption rates in the foreseeable future (Raikwar, Gligoroski, & Kralevska, 2019; Yaga, Mell, Roby, & Scarfone, 2019; CPA Canada, 2017).

3. BLOCKCHAIN TECHNOLOGY IN ACCOUNTING LITERATURE

3.1. Changes in Accounting Definitions

The evolution of accounting information systems spans epochs from ancient eras to the contemporary information age, adapting in response to diverse economic, technological, and environmental landscapes (Anandarajan, Srinivasan, & Anandarajan, 2004). Historical accounting methodologies can be delineated into two primary systems: single-entry and double-entry bookkeeping. Yamey (1947) notes the initial foray into accounting was marked by the single-entry system, which persists among small enterprises, predominantly relying on profit and loss accounts (Örten, Kurt, & Torun, 2011).

The inception of the double-entry bookkeeping system dates back to late 13th and early 14th-century Northern Italy, accredited to Venetian merchants, often referred to as the "Venetian method" (Sangster & Santini, 2022). Luca Pacioli, in his work "Summa de Arithmetica, Geometria, Proportioni et Proportionalita," elucidated the principles of this system, solidifying its existing practices in Venice and ensuring its perpetuation to the present era (Carruthers & Espeland, 1991; Ovunda, 2015; Elbannan, 2007; Fazzini, Fici, Montrone, & Terzani, 2016). Spanning over six centuries, the double-entry method has endured economic fluctuations, reforms, and technological advancements, emerging as the foundational accounting system. It remains the singularly dominant method complemented by various techniques tailored to meet evolving economic and financial accounting requisites (Pascual Pedreño, Gelashvili, & Pascual Nebreda, 2021).

3.2. Triple-Entry Accounting with Blockchain

Yuri Ijiri's article "Triple-Entry Bookkeeping and Income Momentum" in 1982 marked the inception of the triple-entry system, advocating an expansion beyond the double-entry method (Cai, 2021). Although Ijiri's work is distinct from cryptographic or blockchain frameworks, it has garnered attention in the blockchain and accounting scholarly realm. Subsequent to Ijiri, Ian Grigg introduced the TEA (Triple-Entry Accounting) model, emphasizing the use of digital signature cryptography to forge secure transaction records, providing resilience against unauthorized modifications (Grigg, 2005). In essence, the TEA principle employs signed messages to create shared transaction records among at least three parties, constituting the foundation of the shared ledger (Ibañez, Bayer, Tasca, & Xu, 2021). Grigg (2005) frames triple-entry bookkeeping as an evolutionary step in accounting rather than a revolutionary overhaul. However, the digitization of accounting systems, though prevalent since the 1990s, has predominantly witnessed changes in the tools employed rather than a comprehensive digitalization of accounting systems (Doğan & Ertugay, 2019).

Nevertheless, current surveys, such as KPMG's assessment of digitalization in accounting, reveal a prevalent lack of an end-to-end digital process, presenting challenges due to the absence of digital receipts and documents, as cited by 60% of respondents (KPMG, 2021). The 21st-century accounting profession faces the necessity of a novel model aligning with technological advancements and digital transformation processes (Gulin, Hladika, & Valenta, 2019). There's a consensus in academic studies and industry reports that technologies like artificial intelligence, Internet of Things, blockchain, cloud computing, and big data, categorically within Industry 4.0, alongside smart autonomous production systems, will significantly reshape accounting practices (Gulin, Hladika, & Valenta, 2019; KPMG Forbes Insights, 2017; PwC, 2020; Aksoy, 2017; Gönen & Rasgen, 2019; Usul & Başkurt, 2022).

Blockchain, earmarked for substantial change in the accounting sector, fundamentally operates as an accounting technology, housing financial data and tracking asset ownership transfers through tokens (ICAEW, 2018). The accounting domain stands to benefit considerably from distributed ledger records and blockchain technology, promising reduced error and fraud risks, automated systems, cost-efficiency, enhanced financial reporting reliability, and reduced workloads (Faccia & Mosteanu, 2019). Fuller and Markelevich (2020) emphasize blockchain's potential for accountants and investors, ensuring reliability by eradicating accounting information errors and fraud risks. A blockchain-based accounting system functions as a software solution facilitating monetary exchange, recording transactions, and guaranteeing accuracy and reliability by third-party verification in a distributed ledger (Doğan & Ertugay, 2019).

Despite Ijiri's (1986) introduction of TEA in the literature, Grigg's work (2005) is deemed the genesis, though unrelated to blockchain-based accounting systems. Consequently, this form of record is commonly termed a "triple-entry accounting system" in academic publications (Ibañez, Bayer, Tasca, & Xu, 2021; Faccia & Mosteanu, 2019; Cai, 2021). Literature also presents diverse proposals for integrating blockchain in accounting, encompassing studies on triple-entry systems, suggestions by Dai (2017), Schmitz & Leoni (2019), Ibañez et al. (2022) on blockchain and smart contract applications creating novel accounting systems, Smith (2018) advocating continuous accounting processes due to blockchain and AI impacts on reporting, and Kahyaoğlu (2019) exploring real-time accounting or privacy achieved through blockchain-based TEA methods. Additionally, another accounting innovation related to blockchain is the World Wide Ledger (WWL), defined by Tapscott (2016) as a blockchain accounting application offering managers and stakeholders accessible, auditable, and reliable information on personal computers.

4. OVERVIEW OF THE ROLE OF BLOCKCHAIN IN EXTERNAL AUDITING

Companies serve as pivotal contributors to a nation's economic development, and their financial information stands as a vital demonstration of resource utilization and value addition. However, in today's intricate and dynamic business landscape, characterized by Barlaup, Iren, and Stuart (2009) as increasingly complex, the need for dependable information has heightened, leading to questioning the trustworthiness of data provided to stakeholders. Stakeholders, including both internal and external users, seek independent audits to access information assessed by impartial entities without conflicts of interest, aligning with their informational requirements (Selimoğlu & Uzay, 2019). The Independent Audit Regulation of 26.12.2012 defines independent audit as the rigorous process of scrutinizing and evaluating financial statements and other monetary information present in records and documents, adhering to independent audit techniques specified in auditing standards.

This process aims to acquire adequate and appropriate evidence ensuring reasonable assurance regarding the accuracy and conformity of financial statements and other financial data with established financial reporting standards.

Audit and control mechanisms exist primarily to assure shareholders, regulators, governments, and other pertinent stakeholders. Ultimately, the objective of an audit, as per ISRE 2400 revised in 2012, is to bolster confidence levels among financial statement readers (ISRE 2400 revised, 2012). Güredin and Uyar (2021) emphasize the audit's critical role as an independent assurance mechanism, ensuring the reliability of financial statements. However, incidents such as the Enron, Tyco, and WorldCom scandals in the United States during 2001 significantly undermined investor confidence in capital markets and audit firms, becoming a transformative milestone for the audit profession (TÜRMOB, 2002; Ayboğa, 2021).

Responding to these crises, the Securities and Exchange Commission (SEC) enacted the Sarbanes-Oxley Act (SOX) in 2002 (Ortman, 2018) to enhance corporate governance practices, subsequently leading to worldwide updates in common auditing standards and the establishment of new oversight mechanisms aimed at enhancing the quality and reliability of independent audits (Uyar, 2015). However, post-Enron, scandals such as Parmalat, Lehman Brothers, Tesco, and Toshiba have continued to shake global confidence in the audit sector, a sentiment echoed in numerous scholarly works, underlining the ongoing recovery phase of public trust (Awolowo et al., 2018; Donnelly & Hartman, 2020; Barlaup et al., 2009; Ebhodaghe & Omoregie, 2020; Agrawal & Chadha, 2005; BEIS, 2021).

In this context, the potential to restore trust and transparency to investors is pivotal for the accounting and auditing industry, still recovering from past scandals. In contrast to traditional human-based systems, blockchain technology offers a decentralized approach, potentially increasing efficiency by significantly reducing trust costs (Casey & Vigna, 2018; Gudgeon et al., 2020; Varma, 2019; Swan & De Filippi, 2017; Ortman, 2018). Present audit methodologies, focusing on retrospective evidence acquisition and sampling, need adaptation to address the contemporary economy's vast databases holding numerous daily transactions vulnerable to cybersecurity threats. External auditors must consider the implications of audit analytics and emerging technologies like blockchain to deliver high-quality audits in a complex ecosystem, aiming to continue delivering value to the public (Swan M., 2015).

Furthermore, research and trials have revealed the extensive benefits of blockchain and distributed ledgers, extending beyond cryptocurrencies (Lemieux & Dener, 2021; Brender et al., 2018; KPMG, 2018). Governments have embarked on pilot projects employing blockchain technology across diverse functions and services, spanning land registration, education, healthcare, procurement, food supply chains, and identity management (IFAC, 2017). IFAC (2017) contends that blockchain is fundamentally a solution in any scenario requiring a dependable record, foreseeing its disruptive potential in finance, particularly its potential application in inter-organizational records like accounting. Thus, comprehending the opportunities and challenges presented by these technologies holds immense significance for accountants and auditors (Rozario & Vasarhelyi, 2018).

5. AUDITING WITH BLOCKCHAIN: OPPORTUNITIES AND CHALLENGES

The conventional audit process historically entails periodic examinations and testing of records by external auditors, often employing various sampling techniques to mitigate risks while recognizing cost and time constraints (POA, 2014). However, this method inherently involves a large volume of unaudited data, rendering practical assurance below 100% (İşseveroğlu, 2019). As blockchain technology finds full integration into business environments, the projected development of blockchain-supported audit processes anticipates significant time reductions by automating audit tests (Dai & Vasarhelyi, 2017; EY, 2019).

Data stored within a blockchain network is cryptographically encrypted, undergoes consensus approval, and is published across the entire network, featuring timestamps and unique hash IDs per information block. This characteristic generates an immutable audit trail, an indispensable tool for auditors in substantiating audit evidence that is sufficient, relevant, and reliable (KGK, 2018). Blockchain networks efficiently store both financial and non-financial data, enhancing audit procedures' accuracy by leveraging varied information types, nurturing the concept of continuous and comprehensive auditing (Rosario & Thomas, 2019; Smith, 2018).

Traditionally, the audit process commences with diverse data and schedules, necessitating significant planning time (CPA, 2017). Access to real-time or near-real-time data facilitated by blockchain nodes streamlines auditor access to consistent, repeatable information. Unlike traditional practices involving data reconciliation from various sources, blockchain's single distributed database obviates the need for such reconciliation, thereby potentially reducing audit costs (Brender et al., 2018; Li, 2021). Additionally, EY (2019) emphasizes that real-time data accessibility on blockchain offers auditors and regulators unprecedented transparency and continuous traceability, enhancing audit integrity.

5.1 Smart Contracts and Audit Procedures

Smart contracts are systems that require a human element at the input and control stages, but are essentially automated and executed by computers (Clack, Bakshi, & Braine, 2016). CPA (2017) defines smart contracts as a technological advancement that has the potential to speed up business operations, minimize operational errors and increase cost efficiency. Accounting and auditing practices are inherently a system in which the human element is involved in all processes. However, smart contracts, which operate on a shared database using the blockchain protocol, transform the need for human-involved functions into programmed and automatically executed systems (Schmitz & Leoni, 2019). Smart contracts are expected to be of great convenience to accountants and auditors, as they allow the autonomous recording of transactions according to the agreed terms. Dai and Vasarhelyi (2017) explain in their article that if the process of recording sales after the shipment of goods is programmed into a smart contract, the system will first automatically verify the date of shipment and then transfer the sales record to the blockchain. Rosairo and Thomas (2019) stated that smart contracts can be used to create smart audit procedures, and these new audit procedures have great potential to improve audit quality by allowing auditors to perform audit procedures more efficiently and consequently allocate more resources to higher risk areas (Rozario & Vasarhelyi, 2018).

5.2. Challenges of Blockchain

Certainly, the application of blockchain in the audit domain presents both promise and challenges. Despite its inherent immutability and transaction security, blockchain doesn't inherently validate the legitimacy of transactions, necessitating auditor scrutiny to discern between legitimate and fraudulent activities (IFAC, 2017). Current studies affirm that while blockchain holds potential benefits, it doesn't obviate the need for auditor judgment, emphasizing the continued importance of auditor expertise and discernment (Raj, 2017; Garanina, Ranta, & Dumay, 2022; CPA Canada, 2017; Dai & Vasarhelyi, 2017).

Auditors must enhance their technological acumen to craft efficient audit procedures within blockchain systems, gather precise evidence, and identify potential risks (CPA Canada, 2017; Schmitz & Leoni, 2019). When auditing crypto assets, auditors face numerous uncertainties encompassing regulatory, legal, and tax considerations, demanding clear legal frameworks (Türkiye Bilişim Vakfı Blockchain Türkiye, 2021). Scalability issues persist in public blockchain infrastructures, impacting data processing speed, cost-effectiveness, and security, whereas permissioned blockchain networks offer more expedient solutions (Psaila, 2017; Zemankova, 2019; Anis, 2023).

Regulatory ambiguity and ensuring confidentiality of sensitive financial data pose challenges, particularly concerning compliance with data protection laws like the GDPR and KVKK (KPMG, 2023). The requisite technological infrastructure and associated costs further compound the challenges surrounding blockchain implementation in business, accounting, and auditing realms (Anis, 2023).

6. CONCLUSION

Indeed, blockchain's integration into business practices is poised to revolutionize traditional paradigms of trust and transform economic frameworks. Although its implementation in accounting and auditing is nascent, blockchain holds immense potential to reshape these practices and introduce novel business models. As its prevalence increases, a significant shift in accounting and auditing methodologies is on the horizon.

Blockchain redefines accounting procedures, acting as an impartial third-party verifier within the double-entry bookkeeping system. Its feature of immutable, time-stamped records instills trust and transparency, curbing falsification and human intervention, thereby reducing periodic control costs. Distributed ledger systems enable continuous and accessible reconciliation, fostering ongoing accounting and verifiable reporting, albeit with concerns surrounding data confidentiality and trade secret disclosure. Mitigating these risks involves utilizing authorized networks and ensuring data privacy.

While blockchain guarantees trust between transacting parties, verifying data accuracy remains crucial. Accountants and auditors must augment their expertise to accommodate clients embracing blockchain. The anticipated proliferation of blockchain across industries necessitates an expanded skill set to meet evolving client needs.

In auditing, blockchain research emphasizes its potential for continuous auditing and smart contracts. Real-time access to accounting records is anticipated to transform audits into a continuous process, focusing on current data for greater efficiency. Smart contracts facilitate streamlined audit procedures, enhancing audit quality by reallocating resources to higher-risk areas.

The efficiency gains offered by blockchain have the potential to redefine the auditor's role, allowing for deeper analysis. However, challenges loom, including scalability, energy costs, privacy, and cybersecurity. To harness blockchain's potential, further research, pilot studies, and updates to supervisory, regulatory, and ethical frameworks are imperative. This collaborative effort will pave the way for blockchain's integration into accounting and auditing practices, unlocking its transformative potential.

REFERENCES

Agrawal, A., & Chadra, S. (2005). Corporate Governance and Accounting Scandals. *The Journal of Law and Economics*, 48(2), 371-406.

Aksoy, S. (2017). Değişen Teknolojiler ve Endüstri 4.0: Endüstri 4.0'ı Anlamaya Dair Bir Giriş. Sav Katkı, 34-44. www.katki.org/wp-content/ uploads/2020/02/ savkatki4.pdf

Allen, D. (2011). The Institutional Revolution: Measurement and the Economic Emergence of the Modern World. Chicago: University of Chicago Press.

Anandarajan, A., Srinivasan, C. A., & Anandarajan, M. (2004). Historical Overview of Accounting Information Systems. *Business Intelligence Techniques: A Perspective from Accounting And Finance*, 1-19.

Anis, A. (2023). Blockchain in Accounting and Auditing: Unveiling Challenges and Unleashing Opportunities for Digital Transformation in Egypt. *Journal of Humanities and Applied Social Sciences*, 359-380.

Appelbaum, D. (2021). Consensus Mechanisms and Related Issues. *The Emerald Handbook of*

Blockchain for Business, 99–120. Emerald Publishing Limited.

Awolowo, I. F., Garrow, N., Clark, M. C., & Chan, D. (2018). Accounting Scandals: Beyond Corporate Governance. *9th Conference on Financial Markets and Corporate Governance* (FMCG).

Ayboğa, H. (2021). 20. Yılında Enron Olayının Değerlendirilmesi, Muhasebe - Hukuk İlişkilerine Etkisi ve Yapılan Düzenlemeler. *Uluslararası Beşeri ve Sosyal Bilimler İnceleme Dergisi*, 169-179.

Bağımsız Denetim Yönetmeliği. 26 Aralık 2012 Tarihli Resmî Gazete, Sayı: 28509, www.Kgk.Gov.Tr/Portalv2Uploads/Files/Duyurular/V2/Mevzuat/BDY/Guncel%20BDY.Pdf

Barlaup, K., Iren, D. H., & Stuart, I. (2009). Restoring Trust in Auditing: Ethical Discernment and the Adelphia Scandal. *Managerial Auditing Journal*, 24(2), 183-203.

BEIS. (2021). *Restoring Trust in Audit and Corporate Governance*. London: ICAEW.

Bonsón, E., & Bednárová, M. (2019). Blockchain and Its Implications for Accounting and Auditing. *Meditari Accountancy Research*, 27(5), 725-740.

Blockchain Türkiye. En Büyük 4 Denetim Şirketi Blockchain Endüstrisine Nasıl Giriyor? https://Bctr.Org/En-Buyuk-4-Denetim-Sirketi-Blockchain-Endustrisine-Nasil-Giriyor-21133/

Brender, N., Gauthier, M., Morin, J. H., & Salihi, A. (2018). The Potential Impact of Blockchain Technology on Audit Practice. *Journal of Strategic Innovation and Sustainability*.

Cai, C. W. (2021). Triple-Entry Accounting with Blockchain: How Far Have We Come? *Accounting & Finance*, 61(1), 71-93.

Carruthers, B. G., & Espeland, W. N. (1991). Accounting for Rationality: Double-Entry Bookkeeping and the Rhetoric of Economic Rationality. *American Journal of Sociology*, 97(1), 31-69. https://Www.Jstor.Org/Stable/2781637

Casey, M. J., & Vigna, P. (2018). Blockchain: the Future is Here. *MIT Technology Review*, 121(3).

Choudhary, A. S. (2022, 9 29). *Concept of Cryptography in Blockchain*. 11, 8, 2022 Https://Www.Analyticsvidhya.Com/Blog/2022/09/Concept-Of-Cryptography-in-Blockchain

Clack, C. D., Bakshi, V. A., & Braine, L. (2016). Smart Contract Templates: Foundations, Design Landscape and Research Directions. Arxiv Preprint Arxiv:1608.00771.

CPA Canada. (2017). Blockchain Technology and Its Potential Impact on the Audit and Assurance Profession. Deloitte Development LLC. https://www.Cpacanada.Ca/En/Business-And-Accounting-Resources/Audit-And-Assurance/Canadian-Auditing-Standards-Cas/Publications/Impact-Of-Blockchain-On-Audit

Dai, J., & Vasarhelyi, M. A. (2017). Toward Blockchain-Based Accounting and Assurance. *Journal of Information Systems*, 31(3), 5-21.

Doğan, M., & Ertugay, E. (2019). Blokzinciri ve Muhasebe Alanındaki Uygulamaları. *Third Sector Social Economic Review*, 1654-1670.

Dinh, T. T., Liu, R., Zhang, M., Chen, G., Ooi, B. C., & Wang, J. (2018, 7, 1). Untangling Blockchain: A Data Processing View of Blockchain Systems. *IEEE Transactions on Knowledge and Data Engineering*, 30(7), 1366-1385.

Donnelly, A., & Hartman, M. (2020). Building Public Confidence in Audit: Fraud, Going Concern, Public Perception. IFAC. https://www.ifac.org/Knowledge-Gateway/Supporting-International-Standards/Discussion/Building-Public-Confidence-Audit-Fraud-Going-Concern-Public-Perception

Ebhodaghe, L., & Omoregie, N. (2020). The Effects of Accounting Scandals on Public Confidence in Financial Reports. *International Conference on Contemporary Research in Engineering, Science, Management & Arts* https://www.Researchgate.Net/Publication/342945124

El Ioini, N., & Pahl, C. (2018). A Review of Distributed Ledger Technologies. *OTM Confederated International Conferences* "On the Move to Meaningful Internet Systems" 277-288. Springer.

Elbannan, M. A. (2007). Anticipated and Unanticipated Consequences of the Development of Accounting Information Systems. *IRMA International Conference*, 440-443.

Elommal, N., & Manita, R. (2021). How Blockchain Innovation Could Affect the Audit Profession: A Qualitative Study. *Journal of Innovation Economics & Management*, 37-63.

EY. (2019). How Blockchain will Revolutionize Finance and Auditing. EY Global: Https://www.Ey.Com/En_Gl/Digital/Blockchain-Why-Finance-And-Auditing-Will-Never-Be-The-Same

Faccia, A., & Mosteanu, N. R. (2019). Accounting and Blockchain Technology: From Double-Entry to Triple-Entry. *The Business & Management Review*, 10(2), 108-116.

Fazzini, M., Fici, L., Montrone, A., & Terzani, S. (2016). A Modern Look at the Banco De'Medici: Governance and Accountability Systems. *International Business & Economics Research Journal*, 15(6), 271-286.

Fuller, S. H., & Markelevich, A. (2020). Should Accountants Care About Blockchain? *Journal of Corporate Accounting & Finance*, 31(2), 34-46.

Gamage, H. T., Weerasinghe, H. D., & Dias, N. G. (2020). A Survey on Blockchain Technology Concepts, Applications, and Issues. SN Computer Science, 1, 1-15.

Garanina, T., Ranta, M., & Dumay, J. (2022). Blockchain in Accounting Research: Current Trends aand Emerging Topics. Accounting, *Auditing & Accountability Journal*, 1507-1533.

Gönen, S., & Rasgen, M. (2019). Endüstri 4.0 ve Muhasebenin Dijital Dönüşümü. Manas Sosyal Araştırmalar Dergisi, 2898-2917.

Grigg, I. (2005). Triple Entry Accounting. Systemics Inc., 1-10. https://iang.org/Papers/Triple_Entry.html

Gudgeon, L., Perez, D., Harz, D., Livshits , B., & Gervais, A. (2020). The Decentralized Financial Crisis. *Crypto Valley Conference on Blockchain Technology (CVCBT)*, 1-15.

Gulin, D., Hladika, M., & Valenta, I. (2019). Digitalization and the Challenges for the Accounting Profession. *ENTRENOVA-Enterprise Research Innovation*, 428-437.

Güredin, E., & Uyar, S. (2021). Denetim ve Güvence Hizmetleri. İstanbul: Türkmen K.

Herweijer, C., Waughray, D., & Warren, S. (2018). Building Block (Chain)s for a Better Planet. *Geneva: World Economic Forum.* http://www3. weforum. org/Docs/WEF_Building-Blockchains.Pdf.

Ibañez, J. I., Bayer, C. N., Tasca, P., & Xu, J. (2021). The Efficiency of Single Truth: Triple-Entry Accounting. SSRN 3770034. DOI: 10.2139/Ssrn.3770034

Ijiri, Y. (1986). A Framework for Triple-Entry Bookkeeping. *Accounting Review*, 745-759.

ICAEW. (2018). Blockchain and the Future of Accountancy. ICAEW IT Faculty.

International Federation of Accountant IFAC (2012). International Standard on Review Engagements 2400. https://www.Ifac.Org/_Flysystem/Azureprivate/Publications/Files/B012%202013%20IAASB%20Handbook%20ISRE%202400%20.pdf

İşseveroğlu, G. (2019). Bağımsız Denetim Raporunda Kilit Denetim Konuları: BİST Sigorta Şirketlerinin 2017-2018 Yılları Analizi. *Muhasebe ve Finansman Dergisi*, 49-64.

Kahyaoğlu, S. B. (2019). An Analysis on the Implementation of New Approaches and Techniques in the Auditing of Business Processes. B. Darıcı, & F. Ayhan, *Cryrptocurrencies in All Aspects* 93-11. Peter Lang Gmbh.

Kardaş, S. (2019). Blokzincir Teknolojisi: Uzlaşma Protokolleri. *Dicle Üniversitesi Mühendislik Fakültesi Mühendislik Dergisi*, 10(2), 481-496.

KGK. (2014). Bağımsız Denetimde Örnekleme (BDS-530).

https://www.kgk.gov.tr/Portalv2Uploads/Files/PDF%20linkleri/Standartlar%20ve%20ilke%20kararlar%C4%B1/DENET%C4%B0M%20STANDARTLARI/BDS_530.Pdf

KGK. (2018, 6, 6). Bağımsız Denetim Standardı 500 Bağımsız Denetim Kanıtları. https://kgk.gov.tr/Portalv2Uploads/Files/Duyurular/V2/BDS/Bdsyeni25.12.2017/BDS%20500-Site.Pdf

Kim, C. (2021, 9, 21). 3 Ways Staking Will Upend the Economics of Ethereum. As Ethereum 2.0 Goes Live, How Much Can Stakers Make from Validating the Network? *Coindesk*, https://www.Coindesk.Com/Markets/2019/10/25/3-Ways-Staking-Will-Upend-The-Economics-Of-Ethereum/

King, S., & Nadal, S. (2012). Ppcoin: Peer-To-Peer Crypto-Currency with Proof-Of-Stake. *Self-Published Paper*, 19(1). 12 13, 2022

KPMG. (2018). Auditing Blockchain Solution. KPMG International.

KPMG. (2021). Digitalization in Accounting 2021. KPMG AG.

KPMG. (2023). KPMG Perspektifinden Web3.

KPMG Forbes Insights. (2017). Digital Transformation How Advanced Technologies are Impacting Financial Reporting and Auditing. KPMG.

Lemieux, V., & Dener, C. (2021). Blockchain Technology has the Potential to Transform Government, But First We Need to Build Trust WORLDBANK. https://Blogs.Worldbank.Org/Governance/Blockchain-Technology-Has-Potential-Transform-Government-First-We-Need-Build-Trust

Li, J. (2021). Analysis and Research of Blockchain Technology. *Journal of Physics: Conference Series*, 1-6. Doi:10.1088/1742-6596/1744/4/042148

Mainelli, M., & Smith, M. (2015). Sharing Ledgers for Sharing Economies: An Exploration of Mutual Distributed Ledgers Aka Blockchain Technology. *The Journal of Financial Perspectives: Fintech*, 3-44.

Medium. (2019,12 4) Top 10 Tech Giants are Diving into Blockchain. 12 21, 2023 https://Medium.Com/Aelfblockchain/Top-10-Tech-Giants-Are-Diving-Into-Blockchain-A2e7d9b44697

Nakamoto, S. (2008). Bitcoin: A Peer-To-Peer Electronic Cash System. *Decentralized Business Review*.

Ortman, C. (2018). Blockchain and the Future of the Audit. CMC Senior Theses. http://Scholarship.Claremont.Edu/Cmc_Theses/1983

Otero, A. R., & Fink, R. P. (2021). Evaluation Approach for an Effective Blockchain Implementation in an Accounting Environment. *Communications of the IIMA*, 19(1),1-27. https://Scholarworks.Lib.Csusb.Edu/Ciima/Vol19/Iss1/5

Ovunda, A. S. (2015). Luca Pacioli's Double-Entry System of Accounting: A Critique. *Research Journal of Finance and Accounting*, 6(8).

Örten, R., Kurt, G., & Torun, S. (2011). Muhasebede Çift Taraflı Kayıtlama ve Kitab-Us Siyakat. *Muhasebe ve Finans Tarihi Araştırmaları Dergisi*, 34-69.

Pascual Pedreño, E., Gelashvili, V., & Pascual Nebreda, L. (2021). Blockchain and Its Application to Accounting. *Intangible Capital*, 17(1), 116.

Popper, N. (2017.12, 7) Bitcoin's Price has Soared. What Comes Next? 12 21, 2023, The New York Times. https://www.nytimes.com/2017/12/07/Technology/Bitcoin-Price-Rise.Html

Psaila, S. (2017). Blockchain: A Game Changer for Audit Processes. Deloitte Malta, 1-4.

Pwc. (2020). Digitalisation In Finance and Accounting COVID-19 – A Catalyst For Change?

Raikwar, M., Gligoroski, D., & Kralevska, K. (2019). Sok of Used Cryptography in Blockchain. *IEEE Access*, 7, 148550-148575. Doi: 10.1109/ACCESS.2019.2946983

Raj, R. V. (2017). Will External Audits Vanish in The Blockchain World. *IFAC, Audit & Assurance*,2. Https://Www.Ifac.Org/Knowledge-Gateway/Supporting-International-Standards/Discussion/Will-External-Audits-Vanish-Blockchain-World

Rejeb, A., Rejeb, K., & Keogh, J. G. (2021). Centralized vs. Decentralized Ledgers in the Money Supply Process: A SWOT Analysis. *Quantitative Finance and Economics*, 5(1), 40-66.

Rozario, A. M., & Thomas, C. (2019). Reengineering the Audit with Blockchain and Smart Contracts. *Journal of Emerging Technologies in Accounting*, 16(1), 21-35.

Rozario, A. M., & Vasarhelyi, M. A. (2018). Auditing with Smart Contracts. *International Journal of Digital Accounting Research*, 1-27.

Sakız, B., & Gencer Hiç, A. (2019). Blockchain Technology and Its Impact on the Global Economy. *International Conference on Eurasian Economies Famagusta: Eastern Mediterranean University Press*, 98-105.

Sangster, A., & Santini, F. (2022). Lost in Translation: Pacioli's De Computis Et Scripturis. *Accounting History*, 27(3), 311-342. Doi:Https://Doi.Org/10.1177/10323732221109844

Sarmah, S. S. (2018). Understanding Blockchain Technology. *Computer Science and Engineering*, 8(2), 23-29. Doi:DOI: 10.5923/J.Computer.20180802.02

Schmitz, J., & Leoni, G. (2019). Accounting and Auditing at the Time of Blockchain Technology: A Research Agenda. *Australian Accounting Review*, 29(2), 331-342.

Selimoğlu, S. K., & Uzay, Ş. (2019). Bağımsız Denetim: Türkiye Denetim Standartları ile Uyumlaştırılmış. Ankara: Nobel.

Sherman, A. T., Javani, F., Zhang, H., & Golaszew, E. (2019). On The Origins and Variations of Blockchain Technologies. *IEEE Security & Privacy*, 17(1), 72-77. Doi: 10.1109/MSEC.2019.2893730

Smith, S. S. (2018). Digitization and Financial Reporting–How Technology Innovation May Drive the Shift Toward Continuous Accounting. *Accounting and Finance Research*, 240-250.

Smith, S. S. (2020). Blockchain, Smart Contracts and Financial Audit Implications. *IUP Journal of Accounting Research & Audit Practices*, 19(1), 7-17.

Statista Research Department. (2023, 9, 6). Size of Blockchain Technology Market Worldwide in 2018 And 2019, with Forecasts from 2020 to 2025. https://www.Statista.Com/Statistics/647231/Worldwide-Blockchain-Technology-Market-Size/

Stott, J. R. (1982). Mastering Principles of Accounts (159 B.). London: Macmillan Education.

Swan, M. (2015). Blockchain: Blueprint for a New Economy. CA: O'Reilly Media, Inc.

Tapscott, D., & Tapscott, A. (2016). Blockchain Revolution. New York: Penguin Random House LLC. https://Itig-Iraq.Iq/Wp-Content/Uploads/2019/05/Blockchain_Revolution.Pdf

Türkiye Bilişim Vakfı, Blockchain Türkiye. (2021). Kripto Varlıkların Vergi-Muhasebe ve Denetim Yönünden İncelenmesi Raporu. İstanbul: Türkiye Bilişim Vakfı Blockchain Türkiye.

TÜRMOB. (2002, Aralık). Bilanço. Sarbanes-Oxley Yasası, 12-15. https://www.Turmob.Org.Tr/Ekutuphane/Detailpdf/9111c22f-Aa6a-4d31-97ba- Cbabbd48d6ec/Aralik-2002

Usul, H., & Başkurt, B. B. (2022). Muhasebede Dördüncü Dönem: Dijitalleşmenin Değiştirdiği Paradigmalar. *Süleyman Demirel Üniversitesi İİBF Dergisi*, 409-421.

Uyar, S. (2015). Denetim Standartlarına Göre Sınırlı Bağımsız Denetim (Finansal Tabloların Gözden Geçirilmesi). *Mali Cozum Dergisi/Financial Analysis*, 16-39.

Ünal, G., & Uluyol, Ç. (2020). Blok Zinciri Teknolojisi. *Bilişim Teknolojileri Dergisi*, 13(2), 167-175.

Varma, J. R. (2019). Blockchain In Finance. Vikalpa, 44(1), 1-11.

Werbach, K. (2018). The Blockchain and the New Architecture of Trust. Mit Press.

Yaga, D., Mell, P., Roby, N., & Scarfone, K. (2019). Blockchain Technology Overview. Arxiv Preprint Arxiv:1906.11078. *National Institute of Standards and Technology Internal Report*-8202. Doi:Https://Doi.Org/10.6028/NIST.IR.8202

Yamey, B. S. (1947). Notes on the Origin of Double-Entry Bookkeeping. *The Accounting Review*,22(3),263-272. Https://Www.Jstor.Org/Stable/240718

Zemankova, A. (2019). Artificial Intelligence and Blockchain in Audit and Accounting: Literature Review. *Wseas Transactions on Business and Economics*, 568-581.

Zhang, C., Wu, C., & Wang, X. (2020). Overview of Blockchain Consensus Mechanism. In *Proceedings of the 2020 2nd International Conference on Big Data Engineering*,7-12. Doi:Https://Doi.Org/10.1145/3404512.3404522

Zheng, Z., Xie, S., Dai, H., Chen, X., & Wang, H. (2017). An Overview of Blockchain Technology: Architecture, Consensus, and Future Trends. *IEEE International Congress on Big Data (Bigdata Congress)*, 557-564.